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CANET QUICK-FIRE GUNS.

SPECIAL interest attaches to quick-fire guns of heavier caliber at the present time. We give herewith a view of the Canet quick-fire gun adopted by the Russian government, after a trial of various systems, for which we are indebted to the *Engineer*. At some recent trials at Havre, it is said that the 12 cm. gun and 15 cm. guns fired respectively twelve and eight rounds per minute. The *Revue d'Artillerie* says that ten rounds per minute have been obtained with the 15 cm. guns. With smokeless powder a velocity of 880 m. (2,887 ft.) was attained, with a projectile of 40 kilos. (88 lb.) fired from the 15 cm. (5·9 in.) gun. In England it has been found better for the 6 in. gun to separate the cartridge and projectile; it will be seen that this is not done with the Canet *materiel*. We give herewith a description, taken from the *Revue d'Artillerie* of last September, with the above mentioned engraving and facts from *Le Genie Civil*.

Some quick-fire guns of 10 cm., 12 cm., and 15 cm. (3·9 in., 4·7 in., and 5·9 in.) of 48 calibers, of the Canet system, figured in the International Exposition of 1889. In certain trials made by these guns, by employing charges of B N powder for guns of 10 cm. and 15 cm., firing projectiles of 13 and 40 kilos. (28·7 lb. to 88·2 lb.) respectively, muzzle velocities of from 770 m. to 70 m. (2,526 ft. to 230 ft.) have been obtained without exceeding a mean pressure of 2,600 kilos. per centimeter—17½ tons per inch. Two years ago the Societe des Forges et Chantiers de la Mediterranee constructed in their workshops at Havre some quick-fire guns on the Canet system of 40, 45, and 50 calibers, the latter being specially designed for coast batteries. As this design presents certain new arrangements, we will now give a description of it, choosing as our examples the guns of 12 cm. and of 15 cm. of 45 calibers, which are most commonly constructed. The Chilean government have recently received guns of this type from this society for the armament of their cruisers Presidente Errazuris and Presidente Pinto. It was adopted by the Russian navy on the 22d of last July. Fig. 1 shows this gun in action.

Cannon of 12 cm. and 15 cm. of 45 calibers, Canet system.—The quick-fire guns of 12 cm. and of 15 cm., of a total length of 45 calibers, are entirely of steel; they discharge projectiles weighing respectively 21 kilos. and 40 kilos. (46·3 lb. and 88·2 lb.), with velocities of 780 meters and 750 meters (2,559 ft. and 2,460 ft.) These guns are composed simply of a tube which extends the entire length of the piece, of a jacket which rests at the back against a shoulder of the tube, and of a conical hoop in prolongation of the jacket to the front. They are provided with a screw fastening, the screw nut of which is sunk into the tube. They fire a metallic cartridge fixed to the projectile. The gun of 12 cm. (5·1 in.) weighs 3,000 kilos. (nearly 3 tons), and that of 15 cm. weighs 5,700 kilos. (5·6 tons). The mechanism of the breech is shown in Figs. 2, 3, and 4. The closing of the breech, on the screw system, is effected in such a way as to allow of the three movements of rotation, of translation, and of moving to the side, which the working of the screw brings about by means of the slight movement of the lever in the required direction. The screw of the breech A, with interrupted threads on four equal sectors, is carried by a shutter B, whose working is insured by the catch *a*, and the bolt *b*, and connected with a bracket *c*. A circular cavity is made in the rear, in which is fixed a ring with two conical gearing teeth *e*; a shaft *d*, screwed to the center of the breech, prolongs it to the rear. At the bottom of the bracket is a longitudinal groove *f*, along which moves a pivot *g*, turning on a collar K, and on which are fitted: First, a portion of a cogwheel *h* on a vertical axis, which gear with the teeth *e*; second, a two-armed lever, the long arm *l* terminating with a handle P, the short branch *m* bearing a roller *r*, which moves in a horizontal groove *n* under the bracket. The groove includes two parts, one being circular, having its center on the axis of the pivot, the other rectilinear, at an angle with the axis of the gun. The pivot *g* is held

Fig. 2. Rear elevation

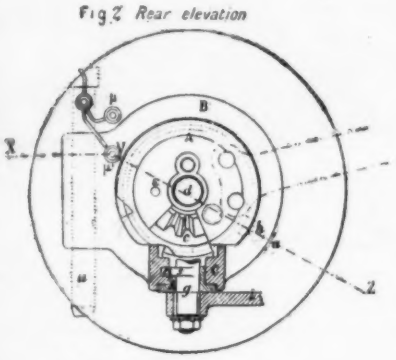


Fig. 4. Section on line X.Y.Z. in Fig. 2.

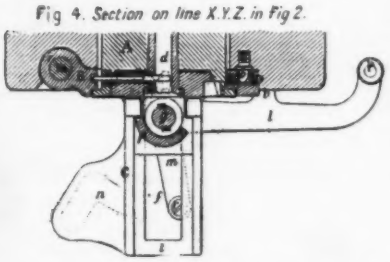
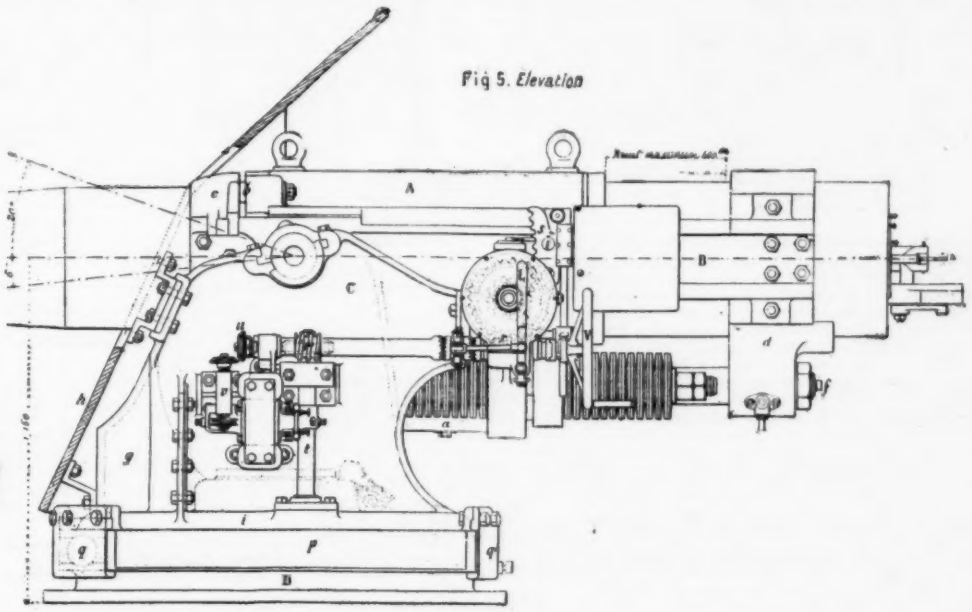


Fig. 5. Elevation



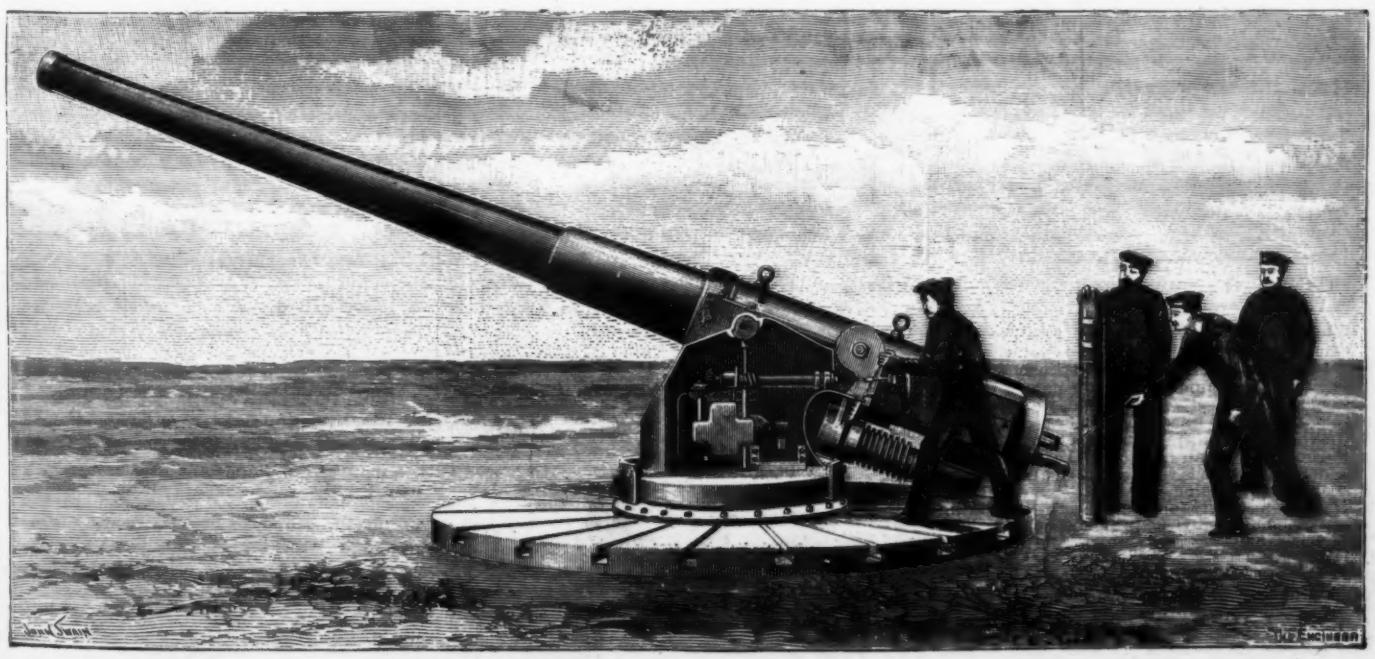
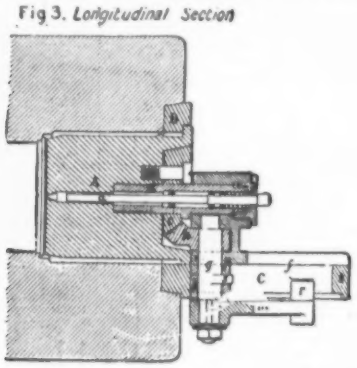


FIG. 1.—CANET QUICK-FIRE GUN FOR THE RUSSIAN GOVERNMENT.

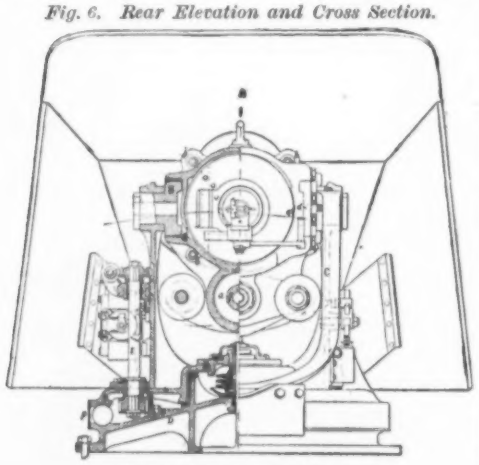
to the screw by means of a connecting piece *p*, formed of two sockets at right angles to each other, in which the pivot and the shaft *d* of the screw turn respectively; this piece moves the screw by contact with the head of a plug Q, fixed at the extremity of the shaft. The breech is opened by a single movement of the handle P from right to left. At the beginning of the movement, the rotation of the lever *l* round the pivot *q* produces the turning of the screw, the teeth *c* of which are moved by the cogwheel *h*; at the same time the roller *r* runs round the circular part of the groove N, and the cog S, which is carried by the pivot, passing through the notch E of the bracket, strikes against the back face of the shutter. On continuing to work the handle, the pivot G as well as the screw of the breech are drawn back, while the roller R sweeps the rectilinear part of the groove. At the end of this movement, the wedge R and the lower part of the impelling piece strike the groove end *t* of the bracket, and the whole system thus assembled pivots round the axis *u* of the shutter until the inclined face of the hinge meets the gun; the breech is then fully opened.* The closing

Fig 3. Longitudinal Section



is also brought about by a single movement, by means of a series of reverse movements. The movement of the lever *l* is limited by a prjoection *v* which comes into contact with the posterior face of the gun, when the threads of the screw have entirely entered into those of the breech. To prevent the accidental turning of the screw while the breech is closed, the lever *l* is furnished with a safety clamp on the body of the gun when the lever has come to an end of its course. When seizing the handle P to open the breech, the gunner bears naturally on it and presses a bell spring by which the safety lock is made to swing, and so free itself; this apparatus is not represented in the figures. It is further completed by an arrangement designed to allow the opening of the breech only when the shot has been fired, the object of which is to prevent accidents in the case of a hang-fire. The apparatus for elevation and direction—see Fig. 5—placed on the left side of the carriage, can be worked either by hand, by means of the same hand wheel V, or electrically. They are organized in the following manner: Two shafts are mounted with slight friction on an axis on the left side of the gun carriage, the shaft behind having an endless screw *r*, which gears with a toothed wheel whose movement is transmitted by an intervening cogwheel to the elevating arc S, fixed on an oscillating frame; the front shaft being equally provided with an endless screw r^1, working on a wheel mounted on the vertical shaft of direction *t*, whose cog wheel gears with *m*—see Fig. 6—for traversing. A collar E, Fig. 5, intermediate between the two shafts and lowered on to the axis, can be engaged at will either with the rear or with the front shaft, by means of a lever L; in the first case it

Fig. 6. Rear Elevation and Cross Section.



CANET GUN—BREECH END.

is arranged for elevation, in the second for direction. To lay it by hand the gunner operates on the one hand with the lever L, on the other with the fly wheel V on the axis. To lay the gun electrically a pawl is raised, which lowers the fly wheel V, and the latter is drawn back in such a way as to uncouple it. The cog wheel U, Fig. 5, is then engaged, mounted on the front extremity of the axis with an auxiliary shaft *v*, moved by the motor. The piece is then elevated and pointed by working on the engaging lever L with a commutator, which gives the desired sense of rotation to the shaft *v*. This commutator is provided with "rheostats," which enable the swiftness of rotation to be varied.

Personnel necessary to the service of the guns.—For the working of the gun of 12 cm., four men are sufficient—a pointer who lays and fires the gun, a gunner who opens and closes the breech, a gunner who loads, and a gunner who removes the empty cartridge. In fact, the pointer can open and shut the breech when it is not necessary to alter the laying much; the number of the gunners is then reduced to three. For the gun of 15 cm. five men are necessary, for two gunners are required to carry the cartridge and load.

* In the guns of 10 cm. and 12 cm. of 48 calibers the mechanism embodied an arrangement which, united with certain parts of the carriage, automatically performed the opening of the breech, when the piece returned into position after recoil. This arrangement was not maintained in the guns of 45 calibers.

ANCIENT ILLUSTRATED MSS. CONCERNING THE HISTORY OF ARTILLERY AND THE MECHANIC ARTS.

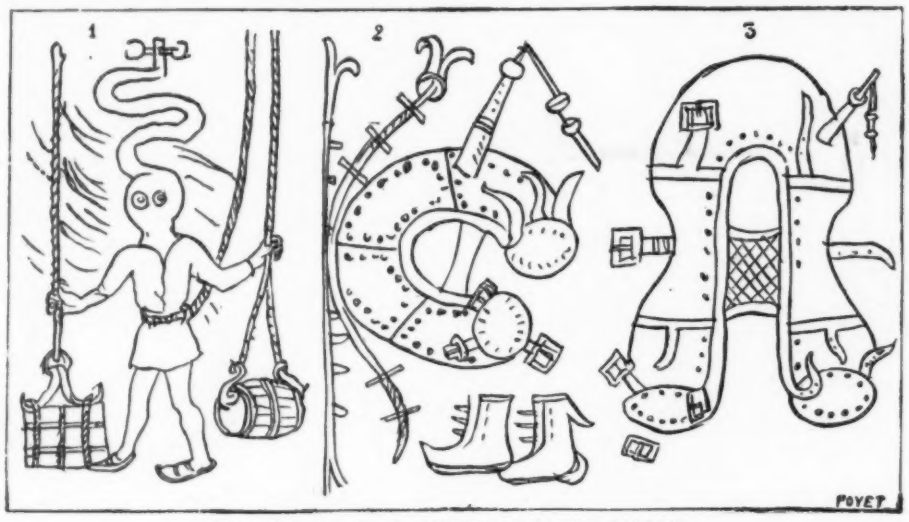
THE researches that I have recently made upon the incendiary compositions of the ancients, the Greek fire and the origin of gunpowder, have led me to examine various figured MSS. written in the early part of the fifteenth century, and which give valuable information as to the history of the mechanic arts and of artillery. I have had sixty-six pages of these MSS. reproduced by photogravure, comprising one hundred and forty-five pictures. The whole is to appear shortly in the *Annales de Chimie et de Physique*. It seems well to call attention to this study by giving a brief abstract of it.

The manuscripts from which these figures were taken are four in number, or five rather, one of them being formed of two others juxtaposed. Four are of the same origin, one appearing to be the rough draught and three the copies. The most ancient belongs to the Royal Library of Munich. It was kindly made known and forwarded to me by the superintendent, Dr. Laubmann. Another exists in the Library of St. Mark, at Venice, and another at Vienna. Finally, there is one in the National Library of Paris.

The Munich MS. (in folio; Latin, No. 197) is in two parts, one in German and the other of Italian origin, which have nothing in common except the binding that unites them.

I. The first book, due to an anonymous German engineer, is composed of forty-eight folios, covered on each side with colored figures of apparatus principally designed for artillery and arsenals, and accompanied in certain cases with legends in old German. They make mention of Munich and Nuremberg and of the events that took place in 1421 and toward 1430 (war of the Hussites). I have reproduced twenty-five pages of them (quarter reduction) that illustrate, among other things, pulley blocks and hoisting apparatus, a boat with wheels, a shielded gun, a pilon powder mill, a diver with his armor, etc.; inventions that are for the most part reputed to be much more modern, but which the exact figures of the MS. carry back to the beginning of the fifteenth century.

I confine myself to the reproduction here (Fig. 1) of the pictures relating to the diver. We see him at the bottom of the water inclosed in his leather armor inflated with air, with eyes protected by glass, and the air tube floating on the surface. The other figures (2 and 3) represent the metallic shoes designed to aid in the descent to the bottom, the girdles, and armor capable of being inflated with air. These drawings are significant. Without going way back to the Problems of Aristotle (xxxii.), in which the author describes how the respiration of the diver is kept up at the bottom of the water by means of air inclosed in an inverted vessel, it will suffice to say that the tradition of the diver is, starting from the fifteenth century, attested in an uninterrupted manner by authentic documents. In certain editions of Vegetius, such as those of 1532 and 1533 (both of Paris), we see on pages 106 to 107, 176 to 177, and 180 to 181, figures of divers like those of the MSS. of which I am going to speak, and which appear to be the prototypes thereof. As a consequence of a singular error, some persons have attributed these figures to Vegetius himself, who says not



FIGS. 1, 2, AND 3.—A DIVER AND HIS ARMOR.

(From a MS. of the fifteenth century.)

a word about them. They are in reality the work of the publishers of the early part of the seventeenth century, as the costume alone of the persons shows at a glance.

I have found similar figures in the French MS. No. 14,727 of the National Library. This MS., which is of small size (18mo), and written in the early part of the seventeenth century, was the memorandum book of a French engineer. On the recto of the fifth before the last folio we see a diver with his suit and his air tube alongside of a large reservoir which seems to be designed to supply him with air. On the verso there is another figure of a diver entirely analogous to that of the Munich MS., and alongside a man provided with a sort of swimming belt. On the following folio there is a naked man under water, breathing the air contained in a bladder, or rather in a leather bottle. This represents a much more primitive type, and one analogous to that of the Problems of Aristotle.

The armor of the diver reproduced herewith was of leather and capable of being inflated, so as to perform the role of swimming belts, as results from the figures that are found near the middle of the volume (No. 14,727). These figures are similar to those of the Munich MS., but are accompanied with an explanatory

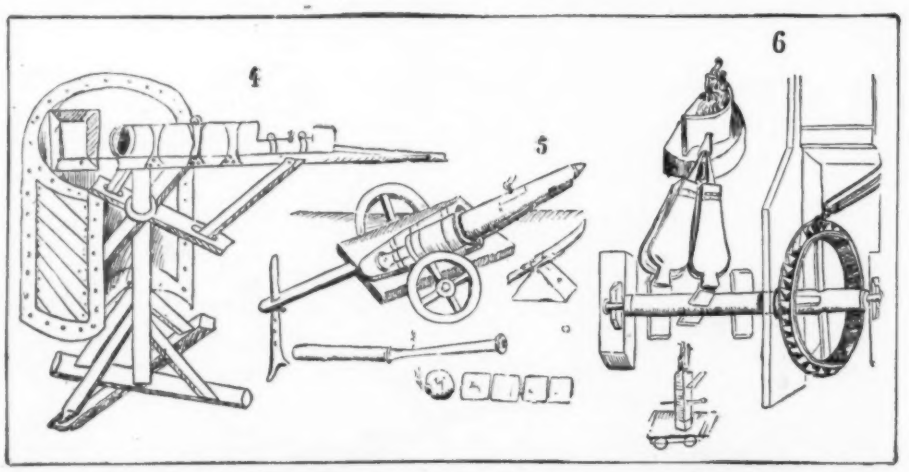


FIG. 4.—PROTECTED GUN. FIG. 5.—A BOMBARD FIRING AN INCENDIARY BOMB.
FIG. 6.—BELLOWS ACTUATED BY AN OVERSHOT WHEEL.

(From a MS. of the fifteenth century.)

legend thus formulated: "Various kinds of leather girdle which may be filled full of air in order to cross a river." Beneath, there is an inflated leather bottle designed to be adapted thereto. I enter into these details in order to point out precisely the ancient character of this important invention, which is sometimes reputed to be modern, although wrongly so.

I shall take again from the Munich MS. the figure of a protected gun of the fifteenth century (Fig. 4).

II. The second part of the Munich MS. is no less curious. It likewise is in folio. It is a memorandum or note book of an Italian engineer concerning building and the mechanical and military arts. I have reproduced twenty-four pages of it concerning hoisting machines, windlasses, bellows, devices for raising water by means of bucket wheels, etc., etc. There are numerous legends written in Latin and Italian, some of which give the precise dates of 1438 and 1441, as well as the name of

the author, speaking in his own name: Marianus Jacobus, of Sienna, a celebrated person of his time, who was called the Archimedes of Sienna. This manuscript, written in his hand, recalls the celebrated memorandum books of Leonardo di Vinci, which Mr. Ravaisson is now publishing.

Among the numerous drawings in this book that I have reproduced, I give here the figure of a bombard

FIG. 7.—BELLOWS FOR RAISING WATER.
(From a MS. of the fifteenth century.)

firing an incendiary bomb after the manner of the ancient ballistæ, one of a portable firearm, and one of a furnace bellows actuated by a water wheel.

The history of the Munich MS. is connected with that of three other and much more finished ones by the same author, and of which it appears to have been the rough draught, for a large number of the figures are reproduced in these MSS.

III. In fact, the Library of St. Mark at Venice contains a treatise, *De Machinis*, containing numerous colored figures, due principally to the same author, although certain of these have been borrowed from another author named Valturius, whose treatise, *De Re*

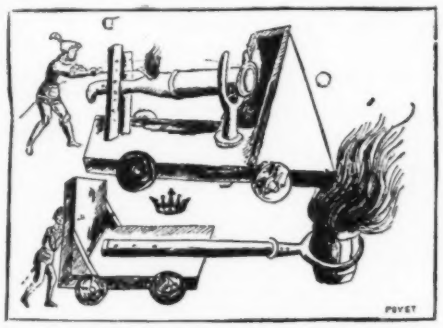


FIG. 8.—BOMBARD AND INCENDIARY CAR.
(From a MS. of the fifteenth century.)

Militari, written toward the middle of the fifteenth century, was printed in 1472 and reprinted several times in the fifteenth and sixteenth centuries. General Fave, in his History of the Progress of Artillery (vol. iii., 1862), gives a certain number of figures imitated from the Venice MS. This latter, which was written in 1449, was dedicated by one Paulus Sanctinus (copyist, draughtsman or plagiarist?) to Barthelemy Coleoni, a great captain of the fifteenth century, who was in the service of the republic of Venice and willed a part of his property thereto. His statue is celebrated.

IV. There exists at Venice a copy of this treatise belonging to Count Vilczek, and similar it appears in all respects to that of Paris. I know of it only by hearsay.

FIG. 9.—CAVALRYMAN USING A FIREARM.
(From a MS. of the fifteenth century.)

V. The National Library of Paris possesses a magnificent MS. (Latin, 7,239) bought at Constantinople by Louis XV., and which the title attributes to Paulus Sanctinus, with the false statement that it was written in 1330 and 1340. It contains a map anterior to the taking of Constantinople (1453), but it was written after the Munich MS., which bears the date of 1441. Hence the real date of the Paris MS. must be about 1450, like that of the two preceding ones. The author or the copyist multiplied the illustrated copies in order to offer them to the princes of his time. Number 7,239, was perhaps sent by him to Sultan Mahomet II., an ally of the petty Italian princes of the epoch.

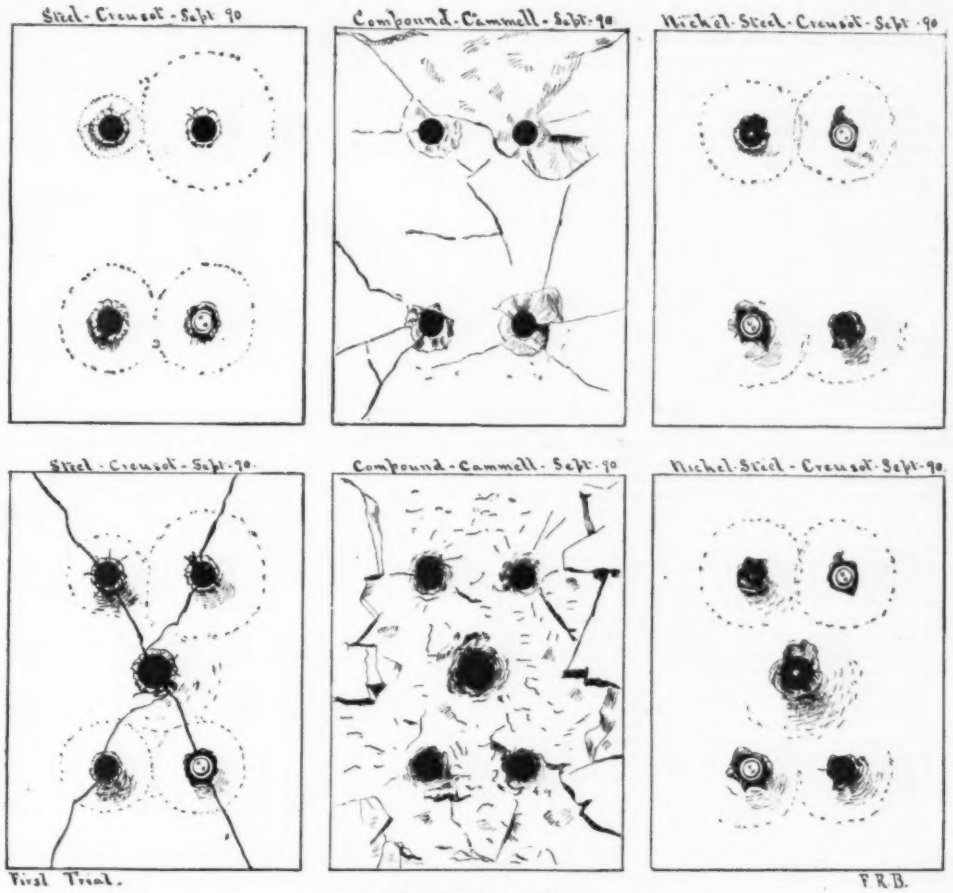
General Fave has reproduced some of the figures of this MS. in facsimile, in his work upon the Greek fire (1845), and Loredan Larchey also, in the Origin of the French Artillery (1863), gives a few. They represent in reality the state of artillery at an epoch anterior by about half a century to that of the MSS., judging from the authentic objects preserved at the Museum of Artillery of Paris. On the contrary, the first book of Munich gives really contemporary drawings of its date.

I have reproduced seventeen pages of the Paris MS. in photogravure (reduced size). I give here three figures only. One of them (Fig. 7) relates to a system of bellows, which represents one of the primitive forms of a pump for lifting water. Another one (Fig. 8) shows the use of artillery simultaneously with that of the incendiary processes of the Middle Ages. Finally, the last (Fig. 9) represents the use of portable firearms in the fifteenth century.

The Paris and Munich MSS. terminate with two similar figures representing the earth surrounded with water, with the central fire, and a Latin inscription non-identical as to words, but of exactly the same signification. It is as follows, according to the Munich MS., the wording of which is stronger:

"Toward the center of the earth there exists a natural fire, which is the life of the entire earth. It is there that all the elements have their origin, the metals and sulphur, for instance, and thence are derived the hot waters. I have with my own eyes seen the mountain of Catana (Ætna) vomiting fire with a great noise. The fire and the air contained in the cavities and pores of the earth raise it, because flames, fire and air naturally tend to rise toward the upper regions."

These lines bear the trace of the physico-chemical theories of the epoch, renewed in part from the Meteorologica of Aristotle. They at the same time confirm the relations of origin of the two MSS., and we may obtain therefrom, as well as from the details that precede, a stronger light upon the history of the ideas and practices relative to the mechanical and military sciences toward the end of the Middle Ages.—*M. Berthelot, in Les Comptes Rendus de l'Academie des Sciences.*


Steel - Creusot - Sept 90
Compound - Cammell - Sept-90
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First Trial.
F.R.B.

ARMOR TRIALS.

[FOR THE SCIENTIFIC AMERICAN.]

ARMOR TESTS AND DEVELOPMENT.

GREAT popular interest has been manifested in the building of our new navy, and recent international events have augmented that interest. We are not only building ships of the best materials and in the best manner known, but each part and department is receiving earnest attention and development.

Our constructors, designers, and builders are studying the results of foreign work, the defects and good points, and are improving on them. Our engineers are developing their branch, and producing engines second to none, and our ordnance officers are meeting with great success in their efforts to produce the best guns and the best armor.

It is safe to say that the navy 6 inch breech loading rifle is the most efficient engine of its class in the world, and the recent development of armor has been more marked in the United States than elsewhere. It is of this development and the method used in testing armor that we propose to speak.

The remarkable experiments began with the trial at Annapolis, Maryland, on the 18th of September, 1890, of two plates manufactured by Schneider & Co., of Le Creusot, France, and one manufactured by Cammell & Co., of Sheffield, England. The second important trial took place at Indian Head, Maryland, about twenty-one miles below Washington, on the Potomac River, where the new naval ordnance proving grounds are, on Oct. 31, 1891. The third important trial took place at Indian Head, on Nov. 14, 1891. The second and third trials were furnished with plates from the Bethlehem Iron Co., of Bethlehem, Pa., and from Carnegie, Phipps & Co., of Pittsburg, Pa.

In the SCIENTIFIC AMERICAN SUPPLEMENT, No. 803, May 23, 1891, will be found a full description of the different methods of making armor plates.

The armor now receiving the greatest study, investigation and experiment may be divided into two classes, the all steel and the alloyed steel.

Methods of face hardening are receiving close study and experiment, and among these methods may be mentioned, as most notable, the process invented by Mr. H. A. Harvey.

The plates for the recent important tests spoken of have been of uniform size, measuring 6 feet in width, 8 feet in height and having a thickness of 10½ inches. Each plate has twelve steel bolts tapped into the rear face, to a depth of 2 inches, and these bolts are a little over 3 feet in length and 2½ inches in diameter. They are used to secure the plate to an oak backing which is 36 inches in thickness and is composed of three layers of 12 by 12 timbers. The timbers of the middle layer are placed crosswise of the other two layers. On each side of the plate is placed a piece of steel of the same thickness as the plate and about 22 inches in width. These pieces are bolted to the backing and support the sides of the plate in the same manner as the neighboring plates would do on a ship's side. The plate with its backing is then placed vertically on a framework of heavy ground timbers and against four uprights which are backed by twelve heavy struts, which latter abut against cleats that are bolted to the framework of ground timbers. Around and between these struts is rammed a lot of earth, thus making a large mound, which serves the double purpose of sustaining the props or struts and retaining stray missiles.

Three plates mounted as above are usually tested at a time. They are arranged on an arc of a circle the center of which is the pivot of the gun. The gun is thus enabled to be pointed normal to the surface of each plate.

In the Annapolis trial the muzzle of the 6 inch gun was distant 28 feet and of the 8 inch gun 30 feet from the face of the plates. In the Indian Head trials the muzzle of the 6 inch gun was distant 57½ feet and of the 8 inch gun 54 feet and 2 inches from the face of the plates.

The guns used in the tests are the 6 inch breech loading rifle and the 8 inch breech loading rifle. These are built-up forged steel guns of the finest class. The shot used were those known as armor-piercing projectiles. The 6 inch projectiles weighed 100 pounds and were propelled by a charge of 42·4 pounds of brown powder, giving a velocity of 2,075 feet per second and a striking energy of 2,988 foot tons per second. The 6 inch projectiles were of Holtzer make and the 8 inch were Firminy's, manufactured by John Firth & Co., of England, and Carpenter's, manufactured by the Carpenter Steel Co., of Reading, Pa. The latter firm is manufacturing projectiles under contract for the government, by the Firminy process, they having bought the right to manufacture under this process in this country. The Firminy 8 inch projectiles weighed 210 pounds and were propelled by a charge of 74½ pounds of brown powder, giving a velocity of 1,850 feet per second and a striking energy of 4,988 foot tons per second. The Carpenter 8 inch projectiles weighed 250 pounds and were propelled by a charge of 72 pounds of brown powder, giving a velo-

city of 1,700 feet per second, and a striking energy of 5,007 foot tons per second.

In all the trials, the plates being in position and the 6 inch rifle ready, a shot was fired at each plate in succession. Then a second shot at each plate was fired, and so on till each plate of the trial had received four 6 inch shots. On each plate the four shots were near the corners, that is, about two feet from the edges of the plate. After this was done, the 8 inch breech loading rifle was substituted for the 6 inch breech loading rifle and an 8 inch shot was fired at the center of each plate in succession. The same routine was carried out in each of the three trials.

These trials were conducted by our government for the purpose of ascertaining the best form of armor that can now be produced, and were not intended to be a competition between manufacturers except in so far as these manufacturers represented a certain class of plates.

The following is a list of the nine plates tested:

In the first trial, the one held at Annapolis, Maryland, September 18-21, 1890, were:

1st. A steel plate manufactured by Schneider & Co., of Le Creusot, France.

2d. A compound plate manufactured by Cammell & Co., of Sheffield, England.

3d. A nickel steel plate manufactured by Schneider & Co., of Le Creusot, France.

In the second trial, the one held at Indian Head, Maryland, October 31, 1891, were:

1st. A high carbon nickel steel plate, manufactured by the Bethlehem Iron Co., of Bethlehem, Pa.

2d. A low carbon nickel steel plate, manufactured by Carnegie, Phipps & Co., of Pittsburg, Pa.

3d. A low carbon steel Harveyized plate, manufactured by the B. I. Co.

In the third trial, the one held at Indian Head, November 14, 1891, were:

1st. A high carbon nickel steel plate, manufactured by C., P. & Co.

2d. A low carbon nickel steel Harveyized plate, manufactured by C., P. & Co.

3d. A high carbon nickel steel Harveyized plate, manufactured by the B. I. Co.

It will be noticed that, of the last six plates, three were furnished by one firm and three by the other; three were treated by the Harvey process and three were untreated: and three were high carbon and three were low carbon. They were all nickel steel except one, the Annapolis trial having practically determined the superiority of nickel steel to plain steel.

What were the results of these three trials? First, let us take the Annapolis trial. The total striking energy of the four 6 inch shots fired at each plate was 11,952 foot tons. The condition of the plates after the four 6 inch shots were fired at each was as follows:

The steel plate was in good condition, showing an inch fringe and an inch front bulge, which was 18 inches in diameter, around each hole, and there were no through cracks. The average penetration was 12·10 inches. The back bulges averaged 2·9 inches high and 15·5 inches in diameter.

The compound plate fared badly, the surface part having cracked very much and the part above the upper shots having chipped off on the front. Every shot went through the plate. The back bulges averaged 6·3 inches high and 19·4 inches in diameter.

The nickel steel plate was in good condition, showing a flaking and a 1·2 inches front bulge, which was 16·8 inches in diameter around the shot holes, and there were no through cracks. The back bulges averaged 4·8 inches high and 19·8 inches in diameter. The average penetration was 14·53 inches.

At the close of the four shot firing it would have been hard to choose between the steel and the nickel steel plate. The penetration was somewhat greater in the nickel steel plate than in the steel plate, but the plate itself was in an apparently slightly better condition than the steel plate.

The fifth shot at each plate was with an eight-inch armor-piercing projectile, Holtzer make, weighing 210 pounds, with a velocity of 1,850 feet per second, giving a striking energy of 4,988 foot tons per second.

After the fifth shot in each the condition of the plates was as follows:

The steel plate had four through cracks radiating from the eight inch shot hole, each extending through one of the six inch shot holes to the top of and bottom of the plate respectively. The cracks varied from 0·15 inch to 0·5 inch in width. A front bulge was raised 1 inch high and 21 inches in diameter and there was little or no fringe. The penetration was 15 inches and the back bulge was 6·3 inches high and 22 inches in diameter.

The compound plate was badly wrecked, especially on the face. The wrought iron back was badly cracked, and the metal showed considerable disintegration. The projectile penetrated plate and backing and went 15 feet into the earth mound. The back bulge was 7·5 inches high and 21 inches in diameter.

The nickel steel plate was in good condition, no cracks being visible. A front bulge was raised an inch in height and 16·5 inches in diameter. There was no fringe, but a chipping out around the edge of the hole, forming a sort of crater. The penetration was 21·2 inches, and a back crater was formed 3·5 inches in height and 21 inches in diameter.

The damage to each of the Creusot plates was principally local, and the nickel steel plate was considered the best and the steel plate was a close second.

The above trial attracted more attention among the naval authorities of the world than any previous armor test, and this was largely due to the fair and impartial manner in which the test was conducted. The use of nickel in steel armor was only tried after numerous experiments in Europe had demonstrated the possibility of obtaining greater tenacity from such an admixture or alloy. Schneider & Co. found that the tensile tests in certain combinations of nickel with steel were very satisfactory, and ballistic tests with small plates yielded promising results, but no nickel steel plate of the size of that used at Annapolis had ever before been subjected to a public competitive trial. Congress showed its appreciation of the importance and worth of this trial by immediately appropriating one million dollars for the purchase of nickel ore, thus controlling the nickel market and preventing a deal being made.

Let us now look at the second trial, which took place on October 31, 1891, at the Naval Ordnance Proving Grounds, at Indian Head, Maryland.

The total energy of the four six inch shots fired at each plate was 11,952 foot tons. The condition of the plates after the four six inch shots were fired at each was as follows:

The high carbon nickel steel plate of the B. I. Co. was in very good condition, having a few small cracks radiating from each hole. There was a front fringe 1·35 inches high and a front bulge 1 inch high and 12·91 inches in diameter around each hole. The average penetration was 11·53 inches.

The low carbon nickel steel plate of the C., P. & Co. was in fair condition. There was a front fringe 1·53 inches high and a front bulge 1 inch high and 17·75 inches in diameter. The average penetration was 19·81 inches.

The low carbon steel Harveyized plate of the B. I. Co. was in fair condition but cracked. The front fringe was 1·13 inches high and there was considerable chipping around the shot holes. The front bulge was an inch high and 15·31 inches in diameter. The average penetration was 10·70 inches.

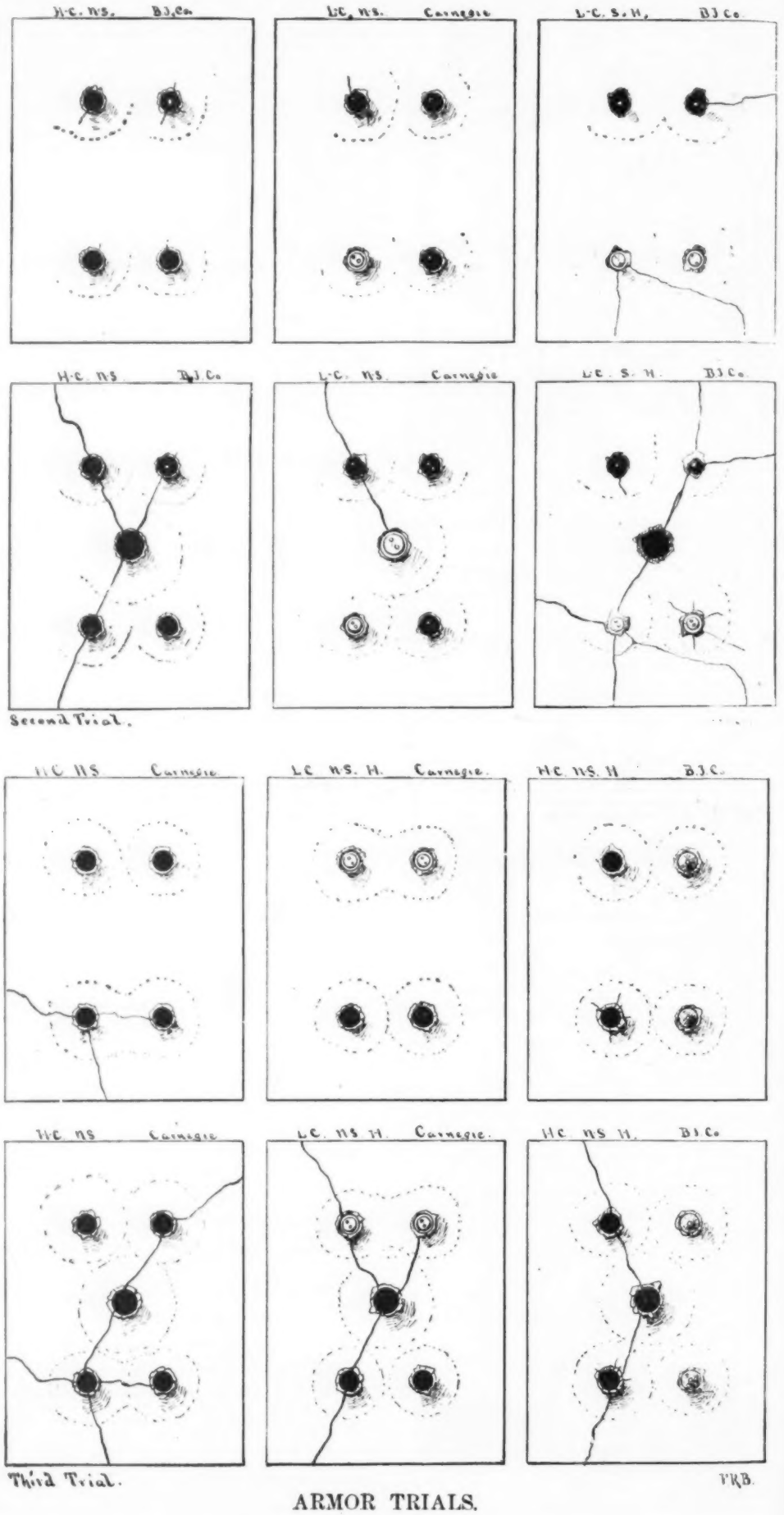
The last plate was perhaps in a slightly better condition at this stage of the trial than the first.

The fifth shot at each plate was with an eight inch Holtzer armor-piercing projectile, weighing 210 pounds, with a velocity 1,850 feet per second, giving a striking energy of 4,988 foot tons per second.

After the fifth shot in each, the condition of the plates was as follows:

The high carbon nickel steel of the B. I. Co. had a serious crack from the upper left corner through the eight inch hole to the lower left corner, and from the eight inch hole up to the right upper six inch hole. There was a front fringe 2·13 inches high and a front bulge 1·5 inches high and 20·75 inches in diameter. The penetration was 15 inches.

The low carbon nickel steel plate of the C., P. & Co. had one through crack developed. There was a front



ARMOR TRIALS.

fringe 1·88 inches high and a front bulge 1·2 inches high and 21 inches in diameter. The penetration was 21·96 inches.

The low carbon steel Harveyized plate of the B. I. Co. was badly cracked in many directions. There was a front fringe 1·25 inches high and a front bulge 1 inch high and 22·5 inches in diameter. The penetration was 43·08 inches.

The high carbon nickel steel plate of the B. I. Co. stood the test better than the others, although slightly cracked and showing a moderate amount of penetration.

The third trial took place on November 14, 1891, at the Naval Ordnance Proving Grounds, at Indian Head, Maryland.

The total energy of the four six inch shots fired at each plate was 11,952 foot tons. The condition of the plates after the four six inch shots were fired at each was as follows:

The high carbon nickel steel plate of the C., P. & Co. was in fair condition, but had two bad cracks in the lower left corner and one connecting the two lower holes. There was a front fringe about 1·35 inches high and a front bulge about one inch high and 18·85 inches in diameter. The average penetration was 11·86 inches.

The low carbon nickel steel Harveyized plate of C., P. & Co. was in good condition, with slight cracking. There was a front fringe two inches high and a front bulge one inch high and 16·69 inches in diameter. The average penetration was 14·79 inches.

The high carbon nickel steel Harveyized plate of the B. I. Co. was in fair condition, with a front fringe averaging 0·75 inch high and a front bulge 0·5 of an inch high and 14·31 inches in diameter. There were a few very fine hair cracks radiating from the shot holes. The average penetration was 8·65 inches.

The choice was evidently with the latter plate, which had a fine appearance and small penetration. The two right hand shots were very remarkable ones, showing that the plate had a wonderful power of resistance on the right side.

A fifth shot was then fired at each plate, the first two being eight inch Carpenters at the high carbon nickel steel of C., P. & Co. and the low carbon nickel steel Harveyized plate of C., P. & Co. and the third an eight inch Firminy at the high carbon nickel steel Harveyized plate of the B. I. Co. The Carpenters weighed 250 pounds and were given a velocity of 1,700 feet per second, thus developing an energy of 5,007 foot tons per second. The Firminy weighed 210 pounds, had a velocity of 1,850 feet per second, and a striking energy of 4,988 foot tons per second.

After the fifth shot in each, the condition of the plates was as follows:

The high carbon nickel steel plate of C., P. & Co. was in poor condition, showing cracks, the worst of which extended from the lower left hand six inch hole to the eight inch hole, to the upper right hand hole and up and out to the side of the plate. The front fringe was 1·75 inches high and the front bulge was 1·5 inches high and 20 inches in diameter. The penetration was 9·63 inches.

The low carbon nickel steel Harveyized plate of C., P. & Co. was not as badly cracked as the high carbon nickel steel, but had two large cracks, one extending from the eight inch hole up through the upper left hand six inch hole and then to the top of the plate, the other from the eight inch hole down through the lower left hand six inch hole, thence to the bottom of the plate. Another crack joined the eight inch hole with the upper right hand six inch hole. The front fringe was about 2·5 inches high and the front bulge 1·5 inches high and 18·5 inches in diameter. The penetration was 15·75 inches.

The high carbon nickel steel Harveyized plate of the B. I. Co. was in good condition, but two cracks having been developed, one extending from the eight inch hole up through the upper left hand six inch hole, thence to the top of the plate, the other from the eight inch hole down through the lower left hand six inch hole, thence to the bottom of the plate. The cracks were not as pronounced as on the other plates. The front fringe was one inch high and the front bulge was 1·25 inches high and 17·0 inches in diameter. The penetration was 12·88 inches.

The best plate of this trial was the high carbon nickel steel Harveyized plate of the B. I. Co.

Let us look for a moment at the leading plate of each trial. These plates are the nickel steel Creusot, the high carbon nickel steel plate of the B. I. Co. and the high carbon nickel steel Harveyized of the B. I. Co.

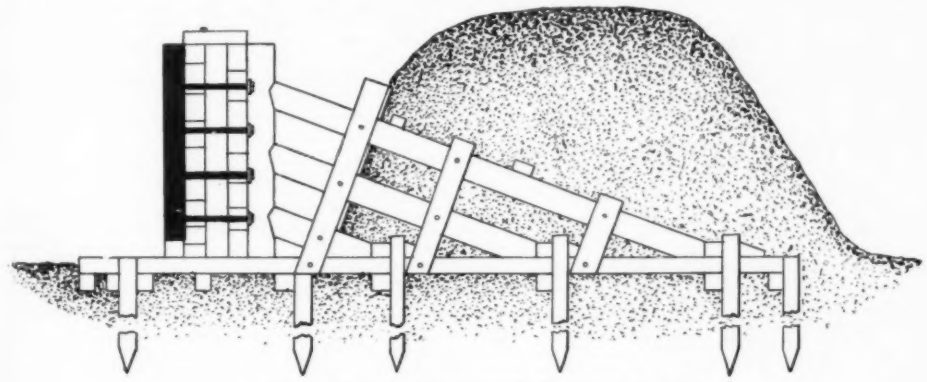
After the four six inch shots had been fired at each plate, we find that the average penetrations in the above order were 14·53, 11·53 and 8·65. So the high carbon nickel steel Harveyized plate of the B. I. Co. had the least penetration. It was also cracked the least, but none of them had more than a few hair line, radial cracks. After the fifth shot at each plate we can arrange the plates, according to the smallness of the amount of through cracking, in the following order of merit: Nickel steel of Creusot, the high carbon nickel steel, Harveyized of the B. I. Co., the high carbon nickel steel plate of the B. I. Co. Arranged according to the amount of penetration, the order of merit is: The high carbon nickel steel Harveyized plate of the B. I. Co., the high carbon nickel steel plate of the B. I. C., the nickel steel of Creusot.

The accompanying table shows at a glance the effect on each plate of the four six inch shots and the one eight inch shot, and the chemical analysis of some of the plates.

TABLE OF PLATES AND RESULTS.

		Steel—Creusot.	Compound—Cammell.	N. S.—Creusot.	H. C. N. S.—B. I. Co.	L. C. N. S.—C., P. & Co.	L. C. S. H.—B. I. Co.	H. C. N. S.—C., P. & Co.	L. C. N. S. H.—C., P. & Co.	H. C. N. S. H.—B. I. Co.
Penetration.	Average 4-6 in.	12·10	Plate and backing	14·53	11·53	19·81	10·70	11·86	14·79	8·65
	Average 8 in..	15·00	Plate and backing	21·20	15·00	21·96	43·08	9·63	15·75	12·88
Diameter Bulge.	Average 4-6 in.	18·00	Chipped	16·80	12·91	17·75	15·31	18·85	16·69	14·31
	Average 8 in...	21·00	"	16·50	20·75	21·00	22·50	20·00	18·50	17·00
Height of Fringe.	Average 4-6 in.	1·00	None	None	1·35	1·53	1·13	1·35	2·00	0·75
	Average 8 in...	Little	"	"	2·13	1·88	1·25	1·75	2·50	1·00
Cracks.	Average 4-6 in.	Several small, no through	Front badly	Several small, no through	Few small	Few small	Several	Several	None	Very small
	Average 8 in...	4 through	Badly	No through	3 through	1 small through	Several bad through	Several large	Few moderate	2 moderate
Carbon		0·33	Face 0·75	0·27		0·26		0·45	0·26	
Manganese		0·50		0·50		0·75		0·65	0·72	
Phosphorus						0·02		0·01	0·02	
Silicon		0·14		0·26						
Sulphur						0·03				
Nickel				3·24		3·27		3·06	3·15	

The second table shows the comparisons between the three C., P. & Co. plates and the three B. I. Co. plates, the three Harveyized plates and the three untreated plates, the three high carbon and the three low carbon plates, also the average penetrations for the home-made plates as compared with the two from Le Creusot, France. The Cammell plate is not included in the comparison, it having been considered too far behind in the race. If it had not been for the unfortunate result of the eight inch shot on the low carbon steel Harveyized plate, the American plates would be much superior to the European, but, even considering that shot, we are proud of the showing.



Target Structure and Framing.

TABLE OF COMPARISONS.

		3 C., P. & Co.	3 B. I. Co.	3 Harvey.	3 Untreated.	3 High Carbon.	3 Low Carbon.	American.	Creusot.
Penetration.	Average 6 in	15·49	10·29	11·38	14·40	10·68	15·10	12·89	13·31
	Average 8 in	15·78	23·65	23·90	15·53	12·50	26·93	19·72	18·10
Diameter Bulge.	Average 6 in	17·76	14·18	15·47	16·50	15·36	16·58		
	Average 8 in	19·83	20·08	19·33	20·58	19·25	20·67		
Height of Fringe.	Average 6 in	1·63	1·08	1·29	1·41	1·15	1·55		
	Average 8 in	2·04	1·46	1·58	1·93	1·63	1·88		
Carbon		0·32		0·32	0·37	0·40	0·29		
Manganese		0·71		0·60	0·69	0·63	0·67		
Phosphorus		0·02		0·02	0·02	0·02	0·02		
Silicon				0·10	0·16	0·13	0·11		
Sulphur				0·04	0·03	0·04	0·03		
Copper				0·05		0·05			
Nickel		3·16		3·03	3·23	3·12	3·21		

Looking over the whole field, we believe the best armor plate is a high carbon nickel steel, with carbon at about 0·36 and nickel at 3·30.

The efficiency of the face carbonizing process is doubtful. It cannot be definitely determined whether or not the process that has been used has materially aided the plate in resisting penetration.

It is but fair to assume that the rolled plate is only a short distance behind the hammered plate in effectiveness.

Quoting from Lieut. W. H. Southerland, U. S. Navy, who is considered an authority on the armor question, we have:

"The weight of present naval opinion is that in future naval actions the element of time will not permit of making a special effort for shattering or racking effects, but that instead every effort will be made to insure perforation by projectiles filled with some powerful high explosive. The terrible results of the explosion of such a projectile within a ship's sides cannot be overestimated, it being very possible for one only to practically put a ship out of action. Of course, any amount of cracking of plate, provided the broken parts remain in place, will be preferable to such a catastrophe." . . . "Hence, supposing a reliable delayed action fuse devised, we will have but one important condition to seek for in our ships' armor, that of successful resistance to perforation, even at the expense of any amount of cracking, provided only that fractured parts be kept in place."

In view of the above statement, we cannot hesitate in choosing the high carbon nickel steel Harveyized plate of the B. I. Co. as the best of all for our purpose. If the left hand side of this plate had more closely resembled the right in resisting quality, this plate would have been much more superior to the average plate than any one had cause to hope for. The cause of the difference between the sides is said to have been in the method of tempering, and no doubt this point will receive careful attention in the future.

The B. I. Co. is very fortunate in having had more experience in the tempering and treatment of large masses of steel than any other firm, and herein lies their strength as the leading armor makers in this country.

Good as the high carbon nickel steel Harveyized plate is, however, it is not as good as we had reason to expect, with all the new ideas and developments of recent months, and it is to be hoped that the future will give us better results.

The very good performance of the rolled plates was a genuine surprise to nearly every one, and the makers have every reason to be pleased with the results. They have succeeded in producing a rolled plate that is a long step in advance of any previous rolled plate, and comes dangerously close in good qualities to the much talked of and prized hammered plate. The hammered plate has many advantages over the rolled and the rolled has a few over the hammered. Under the hammer the plate gets more thorough interior work and the material can be worked at a lower temperature. The work, however, is not so uniform over the whole surface. Immediately under the place where the stroke of the hammer comes the work is well done, but there is a zone between each hammer stroke where there is not as much work done on the material. Under the rolls each element of the plate gets the same amount of work, but the upper and lower surfaces get more than the interior. The rolled plate is, then, as far as work is concerned, more uniform over the whole surface, but lacks uniformity from the front to the back surfaces. The hammered plate approaches uniformity in work from front to back, but lacks uniformity over the whole surface. In making a plate under the hammer, the ingot requires two, three, or perhaps four reheatings before it is finally brought to form. This alone would make the hammered plate to cost much more than the rolled, and at present, in plates of nearly the same quality, the cost of the hammered is double and perhaps treble that of the rolled. The hammer has been so long in use that improvements in handling material under it come very slowly, whereas the improvements in methods of rolling heavy plates are advancing with long strides, and it is not improbable that the rolled plate will soon be abreast of its competitor. Its low cost is of course in its favor, but it must not be lost sight of that the armor problem is to get the greatest amount of protection with the least weight and bulk, and the matter of cost is a secondary consideration.

THE ARMOR TRIALS.

THE general results of the trials of American-made ship armor carried on this year at our naval proving grounds are already known. But herewith are presented exact representations of the penetrations of the entire series of thirty shots fired during the two days, October 31 and November 14. The six 10½ inch plates tested, with the names of the makers and the weights in pounds, were as follows:

High carbon nickel steel, Bethlehem Iron Company	20,494
Low carbon nickel steel, Carnegie, Phipps & Co.	20,844
Low carbon steel, Harvey, Bethlehem Iron Company	20,506
High carbon nickel steel, Carnegie, Phipps & Co	20,590
Low carbon nickel steel, Harvey, Carnegie, Phipps & Co	20,220
High carbon nickel steel, Harvey, Bethlehem Iron Company	20,682

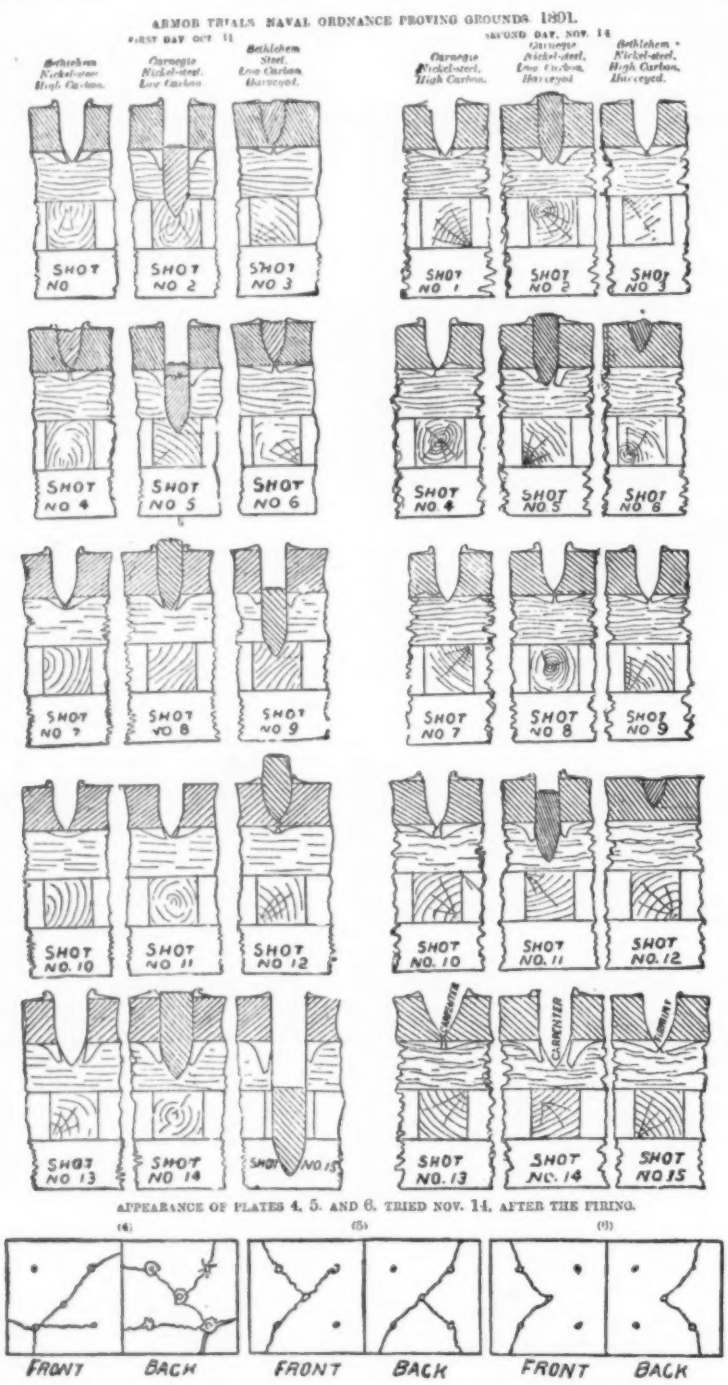
The report of the board, of which Admiral Kimberley was president, states that the size of each plate was 8 feet by 6 feet by 10·5 inches; each was fastened to the backing by twelve bolts 2·36 inches in diameter, giving a total bolt cross section of 52·29 inches square. The targets were set up so that the faces of the plates were on the chords of a circle whose center was the gun pivot, whose radius was 73 feet 5 inches. The muzzle of the 6 inch breech loading rifle was consequently 57·5 feet, and of the 8 inch breech loading rifle 55·5 feet, from the face of the plate when the gun was pointed at

its center, the axis of the gun being then perpendicular to the plane of the plate.

Four shots from the 6 inch gun were fired at each plate, successively at the left upper, right upper, left lower, and right lower corners. The fifth and final shot was from the 8 inch gun at the center. Having described in detail the results of each shot, the board makes the following summary of its conclusions:

After careful consideration of the results of the firing upon the six plates, it was the unanimous decision of the board that they be placed in the following order of merit, viz.:

1. The high carbon nickel steel Harvey plate furnished by the Bethlehem Iron Company.
2. The high carbon nickel steel plate furnished by the Bethlehem Iron Company.
3. The high carbon nickel steel plate furnished by Carnegie, Phipps & Co.
4. The low carbon nickel steel Harvey plate furnished by Carnegie, Phipps & Co.



APPEARANCE OF PLATES 4, 5, AND 6, TRIED NOV. 14, AFTER THE FIRING.

5. The low carbon nickel steel plate furnished by Carnegie, Phipps & Co.
6. The low carbon steel Harvey plate furnished by the Bethlehem Iron Company.

The right side of plate No. 1 showed very remarkable qualities. The two projectiles which struck that side penetrated not more than seven inches, the head remaining in the plate completely filling the hole, and with the appearance of having been welded to the surrounding metal, while the body was shattered into many fragments.

No cracks were made on that side of the plate.

The back of the plate showed no disturbance except a hardly noticeable swelling on the surface.

It is to be noted that the upper part of plate No. 6 (Harveyed) showed qualities resembling those of the right side of No. 1, while on the other hand plate No. 4 (likewise Harveyed) was lacking in such characteristics.

Plate No. 2 showed a great degree of uniformity as well as resistance to penetration.

The small penetration of the 8 inch shot in plate No. 3 was, in the opinion of the board, due to the excessive upsetting of the projectile.

All of the armor plates were more or less cracked through, but only two, Nos. 3 and 6, badly, and these two plates alone showed cracking before the fifth shot.

It should be considered that the firing at this year's trial was more rapid than at last year's, and that the interval between the fourth and fifth shots at each plate was about two hours, instead of four days, as then. At this trial the plates were still "singing" from the blows of the 6 inch when they were struck by the 8 inch projectiles.

The board will, in obedience to the department's order, make a supplemental report upon a "high carbon nickel steel Harvey" plate and "low carbon steel Harvey" plate, to be furnished by Carnegie, Phipps & Co., which will be tried under the same conditions as the six plates whose trial has been completed.

It is to be noted in reference to the foregoing report that the mode of tempering at Bethlehem differed from that at Pittsburg. Although the chief honors of the trial went to the former establishment, yet the degree of excellence in the best plates of the latter vindicated the Navy Department in having entered into a contract with it about a year ago for 6,000 tons of armor plates and appurtenances. Under that contract the prices paid are to be the same as to the Bethlehem Company for similar plates, and all the armor ordered from this firm is to be of nickel steel. The Navy Department supplies nickel oxide, of which it has bought 800 tons. The report of the Chief of Ordnance, Commodore W. M. Folger, declares on this point that "it has been definitely established that armor of excellent quality may be produced by the rolling process, and that forging by means of the hammer is not absolutely necessary—a matter regarding which grave doubts have existed among artillerists for years. It may be considered as probable that within eighteen months, with relatively slight expenditure of money, the present armor-producing capacity of the United States could be quadrupled in case such expansion should become necessary. It is also anticipated that the price at present paid should be materially reduced for the same reasons of active competition and lack of necessity of extraordinary changes in or addition to plant."

Interesting as are these comparisons between the American plates, they become more so on turning to the trials of September, 1890. It will be remembered that then only foreign plates were tested. The nickel steel and all steel plates of Schneider gained a signal victory over the compound plate of Cammell. The nickel steel plate was properly considered the acme of armor protection up to that time. Great interest was, therefore, felt in seeing how American-made armor this year would compare with the French-made armor of last year; for the trials had been made under substantially the same conditions as to guns, projectiles, thickness of plates, backing, and so on, except that two of the 8 inch shells used this year were Carpenter instead of Firminy projectiles. The chief of ordnance tells the result in this respect in declaring that "all the plates showed greater resistance to perforation and less cracking than did the English compound plate of last year. Two of the plates showed greater resistance to perforation and less cracking than did the most resisting plates of last year, the all steel, and, considering everything, were better plates than either the Creusot nickel or the all steel plate of the earlier tests."

In the Bethlehem nickel steel plate treated by the Harvey process, the results were most remarkable and unprecedented, not one of the projectiles, as the illustrations show, having reached the rear surface of the plate. In fact, except for unevenness in tempering, owing to the lack of familiarity with this new process, there would have been a still smaller average of penetration by the shots. The cracking on the softer side of the plate was unimportant. Accordingly the bureau considers that "two important results have been achieved: first, a better plate, of American manufacture, has been produced than the department was able to purchase abroad a year ago; secondly, it has developed a new principle in the manufacture of armor of American origin, which there are good grounds for believing will furnish greater protection to the vital parts of a vessel of war than any other system hitherto employed."

Such are the prominent facts connected with this great trial. It shows that America now stands at the top in the excellence of her ship armor.—*N. Y. Sun.*

THE ATLANTIC LINER—PAST, PRESENT, AND FUTURE.

THE season for making fast transatlantic passages is ended, as vessels now take a more southerly course than in the past two or three months, when there was no probability of icebergs endangering their voyage. There can be no doubt of the success from an engineering point of view of the steamship performances of the season. There has not, it is true, been the same excitement as in the previous season, which is due to the fact that no two fast steamers sail on the same day, as was formerly the case. As the result of an amicable arrangement between the White Star and Inman companies, their fast vessels sail in different weeks, so that it is now possible to make the voyage any week with a vessel capable of accomplishing the sea voyage within six days. There is, indeed, not much to choose between the four vessels. From Southampton, too, the Hamburg-American and North German vessels have been making good runs, so that the transatlantic service each successive year marks a step in advance of the preceding season. In the case of the City of Paris the owners have been devoting more attention to the economizing of coal consumption than to speed since the introduction of Howden's system of forced draught. The sister ship, the City of New York, has been doing very well indeed, and has frequently exceeded 20 knots. The Teutonic and Majestic have both been making good passages. The Majestic has made the westward trip six times under six days, the mean speeds varying from 19·58 to 20·11 knots. The Teutonic has steamed from Queenstown to New York thrice in less than six days, and has also come home thrice within the same period during the season. Of the twelve best passages made by these two steamers this year the mean time is but 5 days 21 hours 5 minutes—a splendid result. Perhaps it will be sufficient to give

Queenstown to New York.

Steamer.	Date.	Passage.	Miles Steamed.	Speed in Knots.
		d. h. m.		
Teutonic.....	Aug., 1891	5 16 31	2778	20·35*
Majestic.....	July, 1891	5 18 8	2777	20·11†
City of Paris.....	Aug., 1889	5 19 18	2788	20·01‡
City of New York...	Oct., 1890	5 21 19	2775	19·63§

* Daily runs: 460, 498, 505, 510, 517, 290 miles.
† Daily runs: 470, 501, 497, 501, 491, 317 miles.
‡ Daily runs: 432, 493, 502, 506, 509, 346 miles.
§ Daily runs: 437, 460, 498, 495, 491, 394 miles.

New York to Queenstown.

Steamer.	Date.	Passage.	Miles Steamed.	Speed in Knots.
		d. h. m.		
Teutonic †.....	Oct., 1891	5 21 3	2790	19·79*
City of Paris	Dec., 1889	5 22 50	2784	19·49
City of New York...	Sept., 1891	5 22 50	2782	19·44
Majestic..	Sept., 1890	5 23 16	2809	19·61

* Daily runs: 483, 468, 468, 460, 440, 457, and 14 miles.
† In November, 1891, the Teutonic came home in 5 days 21 hours 45 minutes, but the distance traveled gave her a mean speed of 19·85 knots.

DIMENSIONS, &c., OF SOME NOTABLE ATLANTIC STEAMERS.

Steamer's Name.	Builders.	Date.	Dimensions			Proportion of Length		Draught.	Displacement.	Gross Tonnage.	Cylinders		Boilers.			Indicated Horse power	Speed on Trial	Admiralty Co-Efficient
			Length.	Breadth.	Depth.	To Beam.	To Depth.				Diameter in Inches.	Stroke.	Heating Surface	Grate Area.	Working Pressure.			
			ft.	ft. in.	ft. in.			ft. in				in.						
Great Eastern	Mr. Scott Russell	1858	680	82 6	58 2	8.23	11.7	25 6	27,000	24,360	..			..	..	7,650	14.50	359
Britannic	Messrs. Harland and Wolff.	1874	455	46 0	34 0	9.89	13.38	23 7	8,500	5,004	Two 48 in., two 83 in.	60	..	..	70	5,500	16	312
Arizona	Fairfield Company	1879	450	45 2	37½ 0	9.96	12.00	18 9		5,147	One 62 in., two 90 in.	66	..	..	90	6,300	17	—
Servia	Messrs. Thomson	1881	515	52 0	40½ 0	9.90	12.62	23 3½	9,000	7,392	One 72 in., two 100 in.	78	27,433	1014	90	10,300	18.9	216
Alaska	Fairfield Company	1881	500	10 0	39 7	10	12.63	21 0		6,932	One 68 in., two 100 in.	72	..	..	100	10,500	18	—
City of Rome	Barrow Company	1881	546	52 0	38½ 0	10.5	9.29	21 6	11,230	8,141	Three 46 in., three 86 in	72	29,286	1396	90	11,800	18.23	256
Aurania	Messrs. Thomson	1882	470	57 0	39 0	8.24	12.05	..		7,269	One 68 in., two 91 in.	72	23,284	1001	90	8,500	17†	—
Oregon	Fairfield Company	1883	500	54 0	30½ 0	9.25	12.57	23 8		7,375	One 70 in., two 104 in.	72	..	..	110	7,375	18.3	—
America	Messrs. Thomson	1884	422	51 0	37½ 0	8.47	11.52	20 7	9,300†	6,500	One 63 in., two 91 in.	66	22,756	882	95	7,354	17.8	339
Umbria	Fairfield Company	1884	501.6	57.2 0	38.2 0	8.76	13.13		10,500	7,718	One 71 in., two 105 in.	72	38,817	1606	110	14,321	19	230
Lahn	" "	1887	465	49 0	30½ 0	9.48	12.83	22 0	7,700	5,661	Two 32½ in., one 68 in., two 85 in.	72	..	..	150	9,500	18.04	266
City of Paris	Messrs. Thomson	1888	560	63 0	43 0	8.89	13.02	24 6	13,000	10,499	Two 45 in., two 71 in., two 113 in.	60	50,265	1293*	150	20,005½	21.8	278
Augusta-Victoria.	Vulcan Co., Stettin	1889	430	56 0	38 0	8.6	11.65	22 9	9,500	7,661	Two 41 7/16 in., two 66½ in. two 106⅛ in.	63	36,000	1120	150	14,110	18.31	—
Columbia	Messrs. Laird Bros.	1889	430	56 0	38 0	8.6	11.65	22 9	9,500	7,578	Two 41 in., two 66 in., two 101 in.	66	24,916	1226	150	13,650	19.15	—
Teutonic	Messrs. Harland and Wolff.	1889	582	57½ 0	39 4	10.1	9.8	26 0	12,000	9,686	Two 43 in., two 68 in., two 110 in.	60	40,072	1154	180	18,000	21	209
Normannia	Fairfield Company	1890	520	57½ 0	38 0	9.09	13.7	22 0	10,500	8,716	Two 40 in., two 67 in., two 106 in	66	46,490	1452	160	16,352	19.34	212
Spree	Vulcan Co., Stettin	1890	485	52 0	38 0	9.33	12.8	22 0	8,900	6,963	Two 38 in., one 75 in., two 106 in.	72	..	..	165	13,000	19.6	249
Fürst Bismarck	" "	1891	502½	57½ 0	38 0	8.73	13.2	22 6	10,200	8,000	Two 43¾ in., two 67 in., two 106½ in.	63	47,000	1450	157	16,412	20.7	254

The Etruria is practically the same as Umbria, the City of Paris and City of New York are alike, so also are the Teutonic and Majestic, and the Spree and Havel. The differences in the case of each pair are not important. * The introduction of Howden's system of forced draught has resulted in the shortening of the firebars by 13 in., bringing the firegrate area to 1026 square feet. The results are under the closed stokehold system of forced draught. † On trial.

the details of the best passages yet made by the four steamers.

Interesting as are the performances of the steamers of the past and of to-day, attention is being directed more to the future. This attention has been in a measure quickened by the prospects of the large number of British residents who will cross to America in 1893, primarily to see the World's Exposition, by the fact that the Cunard Company have ordered two immense steamers from the Fairfield Company, and that the Inman Company contemplate building new vessels; but the matter is in such a condition that we are not far wrong in stating that the ore which is to make the steel for the new vessels has not yet been mined, although in these days such initial stages do not take long. The model of a 23½ knot steamer by Messrs. Thomson, which formed so attractive an exhibit at the Naval Exhibition, has contributed in large degree to the general result. The time, therefore, may not be inopportune for glancing into the future by the experience of the past, assisted by the advantages of that imagination the cultivation of which Mr. Goschen has been so eloquently enjoining on the Edinburgh students.

We give diagrams illustrative of the progress made in fifty years, and through the courtesy of Messrs. James & George Thomson, Limited, we are able to include in our profiles and midship sections some indication of the form of vessel which their extensive and successful experience suggests as the future Atlantic racer. Of the new Cunarders, it is yet too soon to give other than general details.

As to the size of the steamship of the future, financial considerations must determine it. Any addition to size means greater displacement and greater power to get a high rate of speed. A small craft, similar perhaps to a torpedo boat of the Thornycroft or Yarrow build, would give results satisfactory at least on the debit side of the ledger. But what of the credit side, which, after all, is the more important in a merchant

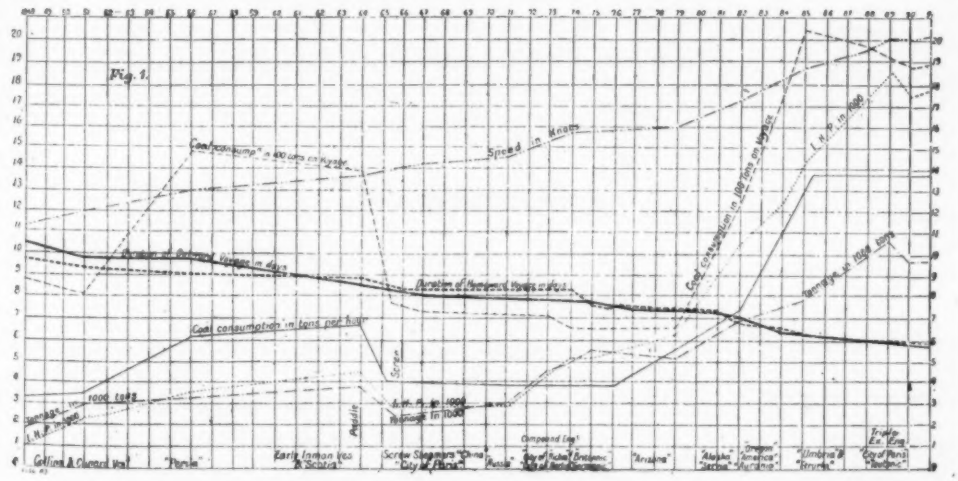


DIAGRAM ILLUSTRATING THE PERFORMANCE OF ATLANTIC LINERS, 1840 TO 1891.

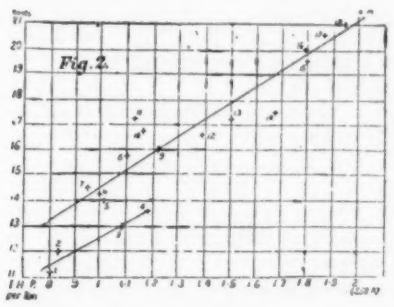
ship of the Atlantic greyhound type? In the case of British ships there are only two sources of revenue—from passengers and for the transport of cargo and mails. In a vessel of the torpedo type there is not room for either. So also with high speed cruisers, where a very large proportion of the length, in some cases 40 per cent., is given up for machinery. Indeed, only in exceptional cases could a cruiser carry fuel to cross the Atlantic at full speed, and certainly no torpedo boat would essay to do so. In the modern high speed passenger steamer the cargo capacity of the vessel is limited, and so valuable that only precious cargo is carried, and that at a pretty high rate. The cause of the limitation is the weight of machinery and of the coal for consumption and the necessity for minimizing the displacement. To compensate for this decreased cargo capacity and to meet the increased expense, it is necessary to secure a larger income, and it may be taken that this can be done more effectually by adding to the passenger accommodation rather than by raising the passenger fares. This means a great increase in the size of the vessel, for passengers cannot well be put below the level of the load water line. It is not necessary to enter into the relationship of power, speed, and size of vessels. Atlantic vessels are built to comply with conditions dictated by financial considerations.

Accompanying this article are profiles of notable vessels, and these show how, as the century has grown old, the size of vessels has become greater. In the newer vessels the dimensions vary, but this is explained by the fact that several of these are of different speeds. As a general rule, it may be taken that the faster vessels are the longer. This is better shown in the diagram of steamship performances, where it is shown that since the advent of the first Cunard screw steamer, a quarter of a century ago, the tonnage of record-breaking vessels has steadily increased, being now triple what it then was, and, although the Teutonic is of lesser tonnage, she is longer than the Inman vessel. The new Cunarder, which the Fairfield Company is to build to attain a speed of 22 knots, is to be greater in size in proportion, practically, to her increase in speed. Increased weight in machinery has been at the expense of cargo room. The engines of the City of Paris, indicating 20,000 indicated horse power, weigh 2,600 tons with boilers, water in condenser, etc., while the engines of the pioneer vessel of the Cunard fleet, the Britannia, of 740 indicated horse power, were only a fraction of this, probably not more than a tenth. The indicated horse power per ton is, in the City of Paris, 7·7, and in the Britannia the proportion would not be greater than 3·5 indicated horse power per ton, if it was that. Although the first Cunarder would look diminutive beside the later craft, the newer vessel can carry very little additional cargo. The City of Paris requires to have 2,500 tons of coal in her bunkers, against 600 in the Britannia, and that notwithstanding that the former vessel does not take half the Britannia's time to cross. The difference financially is made up in passenger accommodation. The City of Paris has taken 1,500, whereas the Britannia only took 115, and special suites of apartments are now provided for those willing to pay for them. We believe £150 has been paid by one passenger for his berth for seven days. Taking one of the leading Atlantic steamers to which we have specifically referred, 80 per cent. of the income is derived from passenger service alone. Messrs. Thomson and the Fairfield Company have arrived at the conclusion that we have not yet reached the limits of size. Indeed, the only limit seems to be as regards harbor accommodation, and Mr. James Deas, harbor engineer at Glasgow, sets the example by constructing a graving dock with a floor 900 ft. long, with a width at bottom of 74 ft., and at entrance of 85 ft., and capable of allowing a vessel drawing 26 ft. to float in. The details of Messrs. Thomson's model we have already published (see *Engineering*, vol. li., page 771). We have also referred to the new Cunarder.

Another point in favor of the large vessel is the possibility offered of providing spacious accommodation. In a small craft it would be impossible to have such a magnificent apartment as the grand saloon in the Inman vessel, where the arched roof rises to a height of 20 ft.

There has been great improvement in the modeling of mercantile steamers, and it is somewhat difficult to realize that these models can be made much finer. We are able to give in a diagram the midship sections of notable vessels, kindly supplied by the respective builders. We regret that our application for the midship section of the Britannic and Teutonic was not successful. They differ in the relation of beam to length from the other vessels. The City of Paris, for instance, has 8·89 of length to 1 of beam, and the Teutonic 10·1 of length to 1 of beam. The midship sections indicate pretty clearly the difference between the various vessels, and we give a table showing the dimensions and the proportions of length to beam and depth, as well as details of the machinery. We have already referred to the necessity of minimizing displacement relative to internal capacity, and with this end in view several of the builders, notably Messrs. Thomson, adopt a broad beam. Some of the German-built boats, too, are beamy. Messrs. Harland & Wolff, on the other hand, adopt a narrow beam. It is not necessary, however, to enter into details, as the table above shows the measurements in each case. We do not anticipate any radical change in the form of vessel, except, of course, it be in the direction of still greater fineness of lines.

As to speed there is really no insurmountable difficulty in attaining 40 knots, but this would require something like 160,000 indicated horse power, 70 boilers to generate the steam for the engines, and these would burn considerably more than 2,000 tons of coal per day. The experience of the past suggests these figures. Some idea may be formed as to the size of vessel necessary for this machinery. We leave it to the imagination of the reader. The question is one of finance, and it might need a company of millionaires to own and run a fleet of such vessels. In ten years the speed has increased from 16 to 20 knots, and in the same time the indicated horse power has gone up from 6,000 to 18,000, while the size of the ship has only been doubled. To attain this result the ship of to-day burns 1,900 tons of coal in six days, whereas ten years ago 600 tons only were burned in 7½ days. A diagram on page 13374 shows the advance in forty years—since the year when the Cunard Company first met with decided opposition. Each horizontal space represents a year. The performances indicated are record-breaking voyages, and the graphs indicating horse power, tonnage, speed, and coal consumption have reference to



the vessel making these record passages. The advent of screw steamers makes a distinct change in the graphs, while the introduction of triple expansion engines has reduced the aggregate coal consumption on the voyage.

In a second diagram appended we have sought to show the relation between speed and power: the ordinates represent knots and the abscissæ indicated horse power per ton. In preparing this diagram we have had to take the gross tonnage, which, for such purposes, is not so suitable as the displacement; but in the case of the older paddle vessels and steamers the displacement is not obtainable from official sources. The figures represent the following steamers:

1. Collins liner America,
2. " " Baltic,
3. Cunard " Persia,
4. " " Scotia,
5. " " China,
6. Inman " City of Paris,
7. Cunard " Russia,
8. White Star liner Britannic,
9. Guion liner Arizona,
10. Cunard liner Aurania,
11. National liner America,
12. Cunard " Servia,
13. Guion " Alaska,
14. Cunard " Oregon,
15. " " Etruria,
16. Inman " City of Paris,
17. White Star liner Teutonic,
18. Inman liner City of Paris at highest speed.

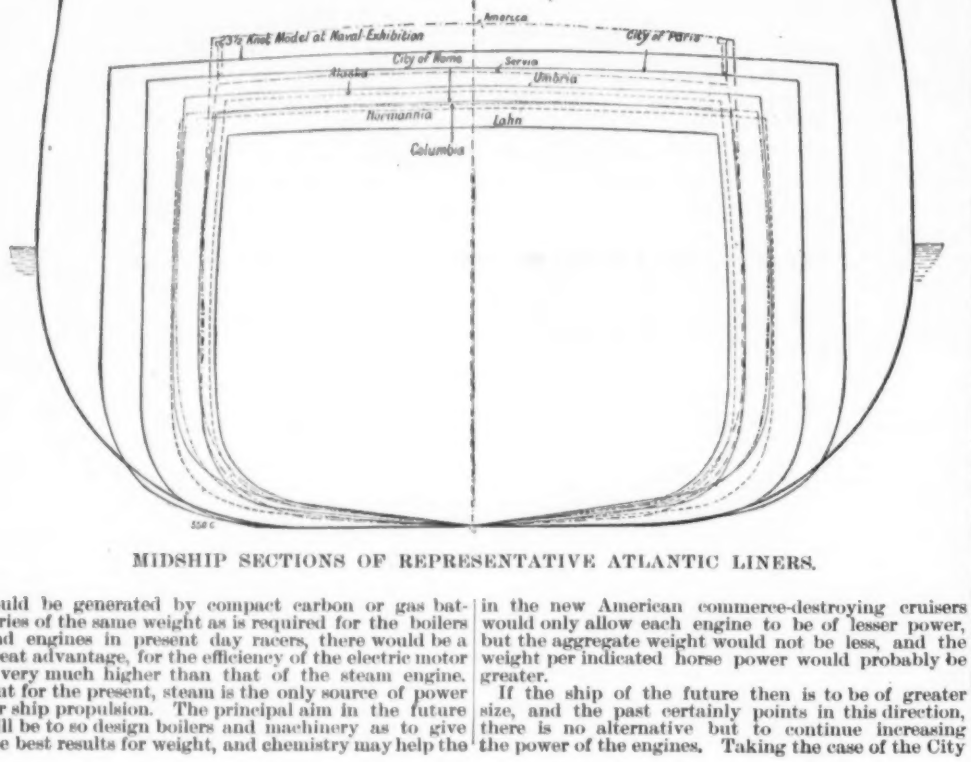
The lines have not been drawn on this diagram as embodying the true law of resistance, but to show the general trend. In the table of dimensions above we have given the Admiralty coefficient of such vessels as we could obtain sufficent information for. The data obtainable, however, for merchant vessels are not so

accurate as those published by the Admiralty, so that the results must be considered only approximate.

No one of the builders of Atlantic steamers entertains any belief in the probability of electricity or any other motive power superseding steam in the propulsion of ships. There is no doubt, however, that if electricity could be generated by compact carbon or gas batteries of the same weight as is required for the boilers and engines in present day racers, there would be a great advantage, for the efficiency of the electric motor is very much higher than that of the steam engine. But for the present, steam is the only source of power for ship propulsion. The principal aim in the future will be to so design boilers and machinery as to give the best results for weight, and chemistry may help the marine engineer by producing an alloy which, reducing the weight, will allow of a higher piston speed. We do not think there is much chance of any material change in propellers. The main idea is to make them of such a size as to enable the engines to revolve at their designed speed. The adoption of three screws as in the new American commerce-destroying cruisers would only allow each engine to be of lesser power, but the aggregate weight would not be less, and the weight per indicated horse power would probably be greater.

If the ship of the future then is to be of greater size, and the past certainly points in this direction, there is no alternative but to continue increasing the power of the engines. Taking the case of the City of Paris, which at her maximum speed of 21 knots required over 20,000 indicated horse power, we find that she would require for 23½ knots speed, 28,000 indicated horse power, and for 25 knots, 34,000 indicated horse power. For an increase in speed of 19 per cent. there is therefore needed an addition of 70 per cent. to the power. Regarding the engines of the new vessel designed by Messrs. Thomson, which is considerably larger, we find that, assuming the draught to be the same as in the City of Paris, 23½ ft., the power required for 21 knots would probably be about 22,350 indicated horse power, for 23½ knots 33,000 indicated horse power, and for 25 knots 40,000 indicated horse power, so that in this case the increase of 19 per cent. in speed is got by an addition of 79 per cent. power. The new vessel, to make 23½ knots, for this increase of 12 per cent. to speed needs 47·5 per cent. more power. To attain this result the new vessel would require 14 boilers, and instead of 320 tons of coal per day she would consume 528 tons, which on a five days' voyage aggregates 2,700 tons, instead of 1,900, as in the six days' voyage of the City of Paris. The Fairfield Company, with a vessel 600 ft. long, intend to have engines of 30,000 indicated horse power, to give 22 or 22½ knots.

There is really no need to discuss the question as to whether the game is worth the candle. The great majority of ocean travelers, and particularly Americans, prefer the faster vessels under all circumstances. Besides, the comforts are greater, and the larger the vessel the more likely she is to be unsinkable and thoroughly seaworthy.—*Engineering.*



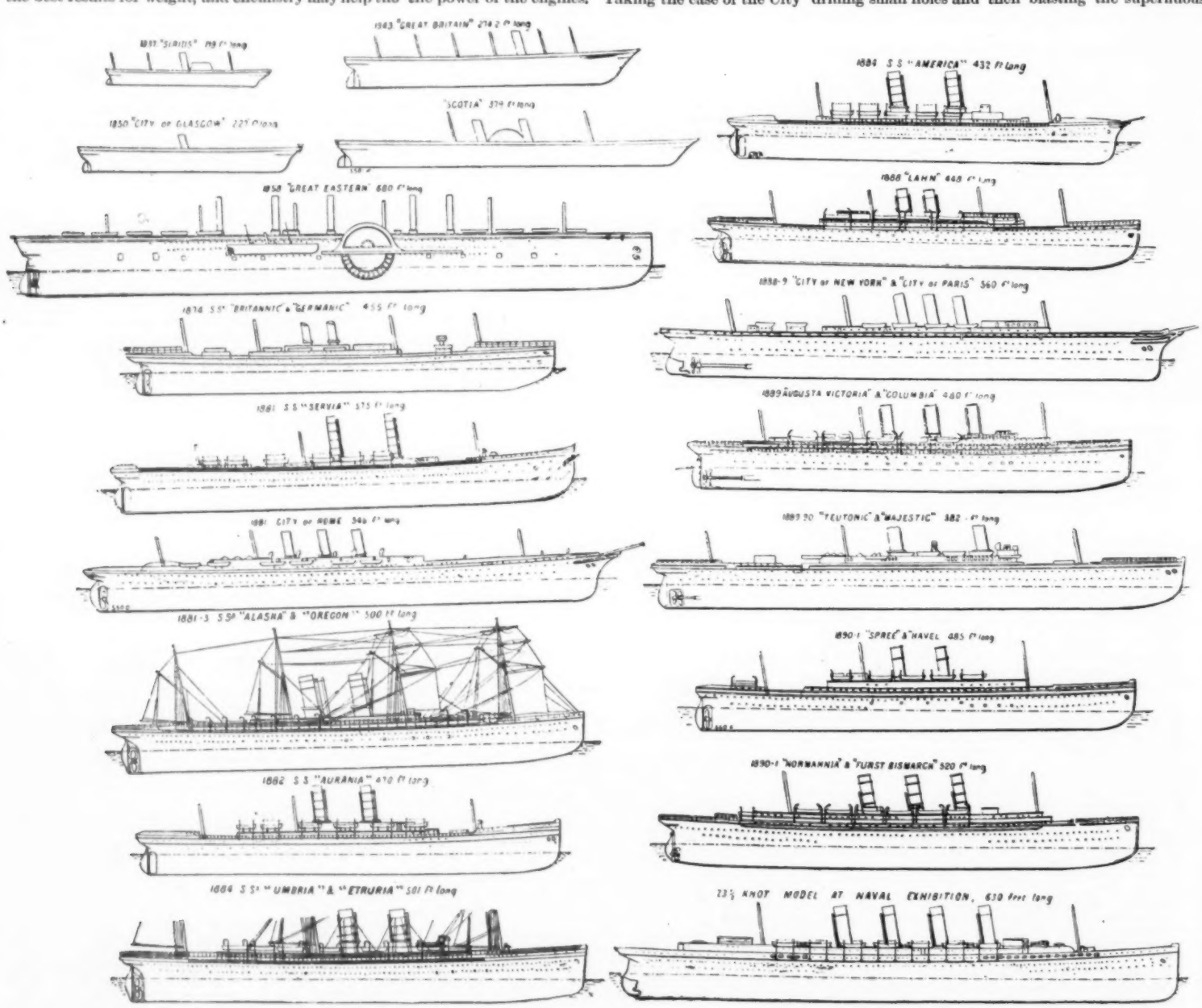
MIDSHIP SECTIONS OF REPRESENTATIVE ATLANTIC LINERS.

PLYMOUTH PROMENADE PIER AND PAVILION.

WE give illustrations of the Plymouth promenade pier and pavilion, which is intended to give a modern finish to the historic promenade of Plymouth. The engraving represents a general elevation and general plan of the pier.

The pier, after passing through a series of vicissitudes, is, with the exception of a few minor additions for the convenience and amusement of visitors, now practically complete. The original designs of the pier were made by the late Mr. Eugenius Birch, M.Inst.C.E., but these were slightly modified during the course of construction under Mr. Frank E. Robinson, engineer.

The pier is of an irregular shape in plan, the outer part being somewhat of a fan shape. The total length is 420 ft., and the greatest width of the fan-shaped part is 200 ft. It is supported upon 140 cast iron columns firmly fixed in the solid rock to a depth of 3 ft. The foundations of the columns consist of bell-shaped castings. Holes for these castings were formed by first drilling small holes and then blasting the superfluous


1843 "GREAT BRITAIN" 274 2 ft long
1837 "SIRIUS" 178 ft long
1884 S.S. "AMERICA" 432 ft long
"SCOTIA" 379 ft long
1850 "CITY OF GLASGOW" 227 ft long
1858 "GREAT EASTERN" 680 ft long
1866 "LAHN" 448 ft Long
1874 S.S. "BRITANNIC" & "GERMANIC" 455 Ft long
1888-9 "CITY OF NEW YORK" & "CITY OF PARIS" 560 ft long
1881 S.S. "SERVIA" 515 ft long
1889 "AUGUSTA VICTORIA" & "COLUMBIA" 440 ft long
1881 CITY OF ROME 546 ft long
1889-90 "TEUTONIC" & "MAJESTIC" 582 ft long
1881-3 S.S. "ALASKA" & "OREGON" 500 ft long
1890-1 "SPREE" & "HAVEL" 485 ft long
1890-1 "NORMANNIA" & "FURST BISMARCK" 520 ft long
1882 S.S. "AURANIA" 470 ft long
1884 S.S. "UMBRIA" & "ETRURIA" 501 ft long
23½ KNOT MODEL AT NAVAL EXHIBITION, 630 feet long

PROFILES OF REPRESENTATIVE ATLANTIC LINERS.

rock to the required depth. The surface of the rock was leveled, and great care taken to secure a good bearing. When the castings were placed in their exact positions, the excavations and interiors of the piles or columns were filled with Portland cement concrete. In deep water the drilling and other work had to be done by divers.

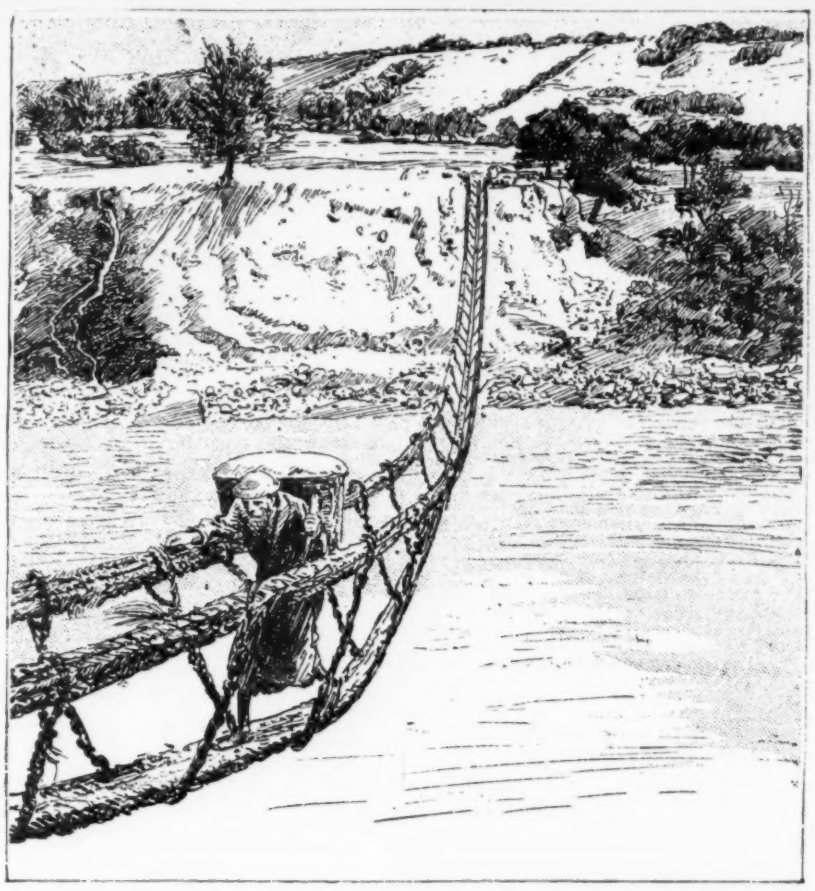
The columns are braced longitudinally and transversely in such a manner as to insure the greatest amount of stiffness to the pier and to offer the least amount of resistance to the sea. Immediately upon the columns are fixed the main wrought iron girders carrying the superstructure. The depth of water at the extreme seaward end of the pier is 38 ft. at high spring tides.

The pier is entered from the Hoe Road, with which it is connected by a solid masonry abutment. Ornamental gateways, with prettily designed toll houses and a refreshment room, surmounted by a clock tower in the center, form an effective group at the entrance. After passing the turnstiles, a sloping roadway 130 ft. wide leads to the pier, but this contracts to 60 ft., as shown in the plan. This width is again reduced to 34 ft. for a length of three spans, when it again widens out to 60 ft. The general inclination is 1 in 14. From the 60 ft. width a curved flight of steps brings the deck of the pier down to a level of about 20 ft. above high water mark. From this flight of steps the pier broadens out to the fan-shaped structure of the width before mentioned, and upon this part is built the pavilion, leaving a promenade of about 20 ft. around it. Around the head of the pier is erected an open cast iron landing stage, supported on timber piles, for the accommodation of steamers and boats at all stages of the tide. The floor of the pier is formed of 2½ in. pitch pine.

The pavilion is stated to be the largest pier pavilion in the kingdom, and measures 125 ft. in diameter. The inner dome is 50 ft. in circumference, the center being 45 ft. in height from the floor. It is octagonal in shape on the inside, and circular outside. The outer circle stands on sixteen columns. The roofing is of iron framework, covered with zinc and glass. On the inside of the pavilion is a balcony 7 ft. wide, carried by iron columns with ornamental brackets, on each of which is fixed the borough arms. Egress is obtained from this balcony through six doors to an open elevated promenade varying in width from 11 ft. to 18 ft. A glass screen separates the two balconies. This is glazed with colored glass, the upper part being of plain glass. Each of the balconies is provided with ornamental balustrades, supplied by Messrs. McFarlane, of Glasgow. Access is obtained to the balconies by two staircases leading from the floor of the pavilion to the inner balcony. The pavilion will seat 2,000 persons, while the balcony will seat a further 1,000, in addition to which a further 2,000 people can promenade on the open balcony.—*Industries.*

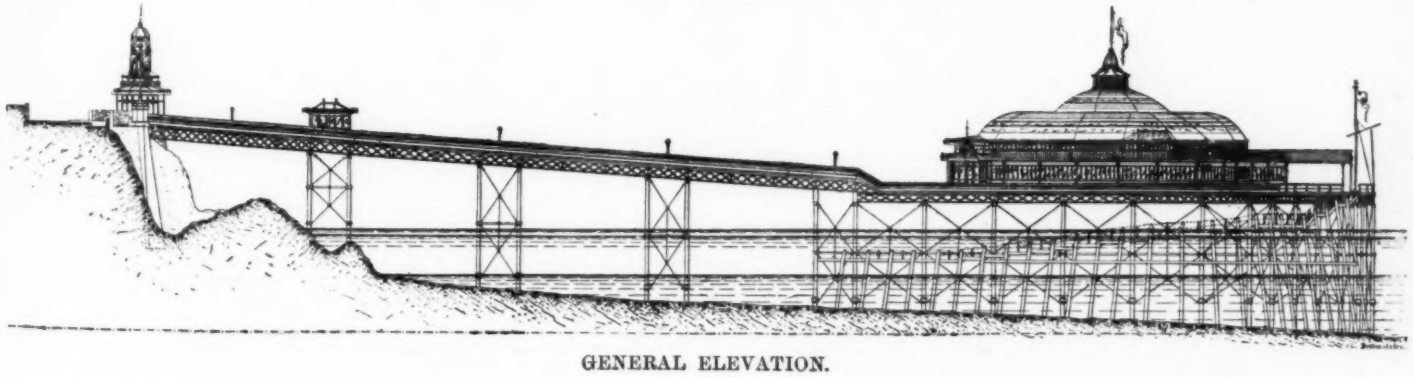
THE BIRCH ROPE BRIDGE AT SHERKILA, CASHMERE.

OUR sketch relates to the recent expedition to Chalt, and shows a remarkable rope bridge running across the Gilgit River near the fort of Sherkila, which was visited by the expedition. The rivers throughout Gilgit would constitute a formidable obstacle to easy communication were it not for these bridges, which are made of rope plaited from birch twigs obtained high up on the mountain sides. They are often of considerable span, and as no great strain can be put on to the material, there is a heavy dip in the center, and a certain free swinging of the bridge in a high wind, which aggravates the difficulty of crossing. In spite of their seeming frailty, however, they will stand the weight of from eight to ten men. The natives walk across with perfect ease, carrying heavy loads on their backs.—*Daily Graphic.*

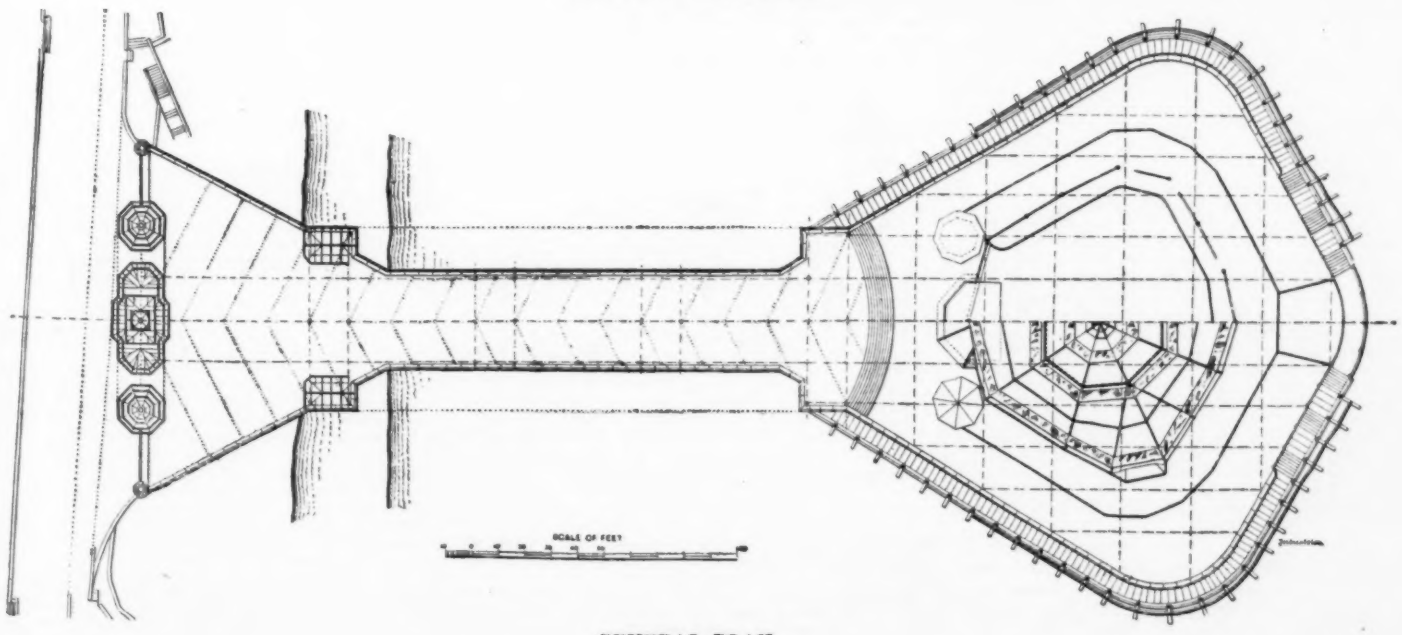


THE BIRCH ROPE BRIDGE AT SHERKILA, CASHMERE.

DR. ROWLAND'S spectroscopic observations on the sun have so far identified sixteen more terrestrial elements as present in our great luminary, making in all thirty-six identified terrestrial elements. As to others there is doubt, and further study is being made. Among the sixteen newly identified elements in the sun are carbon, silicon, silver, zinc, and germanium.



GENERAL ELEVATION.



GENERAL PLAN.

PLYMOUTH PROMENADE PIER AND PAVILION.

CYLINDER OILS.

THE efficient lubrication of a steam or gas engine cylinder is a matter of very great importance to all owners of such a motor, perhaps not so much on account of any increased efficiency of the engine as on account of the influence that good lubrication has on the life of the engine; there is scarcely a machine which wears out quicker if badly lubricated than an engine, and one of the parts which requires the most attention is the cylinder. In lubricating steam engine cylinders there are two conditions present which are not met with in any other machinery. These conditions are a high temperature and water. Now, although water at ordinary temperatures has no action on oils, yet at high temperatures its action is different, especially with the fatty oils. Fatty oils and fats, such as tallow, lard, olive, rape, palm, etc., when subjected to the combined action of water and high temperature, two things always present in a steam engine cylinder, are decomposed into their two constituent parts, the fatty acids characteristic of the oil or fat and glycerine. Taking tallow, for example, when thus treated this fat forms principally stearic acid and glycerine, while palm oil yields principally palmitic acid and glycerine. The glycerine being more or less volatile passes away with the exhaust steam, but the acid, not being volatile, remains behind, and settles in any available spot in the cylinder; being of a corrosive nature, it attacks the metal work of the cylinder wherever it deposits, and eventually corrodes it away. When opening cylinders lubricated with such fats, it is no uncommon thing to take out large black cakes and balls of fatty and metallic matter, and find the interior of the cylinder much pitted, and bolts, etc., almost eaten away through the action of the fatty acids, which have been formed from the fat used to lubricate the cylinder. A sample of black cake taken out of a cylinder examined by the writer showed it to contain:

	Per Cent.
Fatty acid	5·62
Fatty matter, hydrocarbon oil	25·94
Metal, principally iron	68·44
	100·00

There is always a large proportion of metal in these grease balls.

Evidently, the fatty oils are not the most suitable lubricants for engine cylinders, and there is no wonder that the hydrocarbon cylinder oils have almost entirely displaced them for lubricating engine cylinders. These hydrocarbon cylinder oils possess the one great advantage of not being decomposed by the steam present in the cylinder; consequently they have no action on the metal of the cylinder, and a cylinder, when lubricated with a hydrocarbon cylinder oil, is kept cleaner and lasts much longer than it would do if lubricated with tallow, or some other fat.

These hydrocarbon cylinder oils are almost entirely derived from American petroleum; a cylinder oil from Russian petroleum is in the market, but it meets with but little use for this purpose. They are of two classes, which, from their color, may be called black and green cylinder oils. The green are more highly refined than the black. They are obtained from the crude American petroleum by first filtering it, then refining by distillation with heat and superheated steam, so as to drive off all the volatile portions; the residue is then cooled artificially, and the paraffin which crystallizes out separated by filtration, the residue is sent out as cylinder oil. It is of a black color, which some users object to. When a green oil is required, the black oil is taken, filtered again and again through animal charcoal, as well as being treated with caustic soda and sulphuric acid to get all the impurities out of it.

The consistency of these cylinder oils is variable; some are fluids resembling castor oil in viscidness, others approach treacle in this respect, while others again are more of the consistency of butter. The latter class of cylinder oils are not so much used as the more liquid oils, because of the growing use of sight feed lubricators and the necessity of using in them an oil which shall be fluid at all the temperatures to which it may be exposed.

The specific gravity of these cylinder oils averages about 0·890 to 0·895; but specific gravity of these oils is an unimportant matter, and is no guide to their quality.

The flashing point ranges from 530 deg. F. to 580 deg. F., which is the highest temperature observed by the writer. Certainly nothing approaching the standard (680 deg. F.) laid down by the writer on lubricants in Thorpe's "Dictionary of Applied Chemistry" has been reached as yet in cylinder oils. The writer would fix the standard of flash point for cylinder oils at 530 deg. F., although flash points in cylinder oils are a matter of little moment. Given other more essential properties, an oil of a flash point over 400 deg. F. is safe enough.

The property which a cylinder oil should possess above all others, and the one which should be made the standard, is viscosity, for upon this depends the lubricating value of an oil; if its viscosity is low, its lubricating power is low too. On the other hand, given great viscosity, then the lubricating power must be good. But in the case of cylinder oils especially, the oil must not only have a good viscosity at the ordinary temperature, but it must not lose it in too great a degree when heated. Thus, for instance, a sample may have at 80 deg. F. a viscosity of 980, and at 190 deg. F. a viscosity of 60; another sample may, at 80 deg. F., have a viscosity of 680, and at 190 deg. F. one of 95. Now, it is obvious that the first oil is not so good as the second, because there is a greater loss of viscosity when heated; it will, therefore, not lubricate a cylinder so well as the second, although at low temperatures it has more viscosity. The following are typical examples of the cylinder oils now on the market:

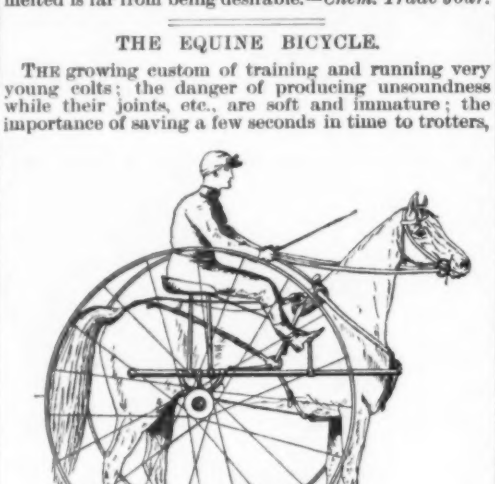
	Black.	Green.	Green.	Amber.	Black.
Specific gravity	0·9618	0·8854	0·8992	0·8838	0·9169
Vapor temperat're	330° F.	250° F.	330° F.	300° F.	408° F.
Flash point	538° F.	486° F.	534° F.	482° F.	500° F.
Fire test	.....	572° F.	620° F.	556° F.	.....
Viscosity at 100° F.	592	297	550	880	1254
Viscosity at 180° F.	74	46	95	60	140

From which it will be seen that it is difficult to lay down a standard for cylinder oils. The viscosities were measured in Hurst's standard viscometer. The last given is a good sample to select as a standard if one is required.

The great objection to the use of the black oils is that, being dark colored, the presence of impurities, such as dirt, bits of straw, etc., are not readily visible. Another defect, from a dealer's point of view, is that, when heated to about 180 deg. F. and then allowed to cool, some crystalline change goes on, which reduces the viscosity of the sample somewhat, besides giving it a lumpy appearance that is not desirable. What is the cause of this change is not certain. The oil dealer generally mixes the oil with some fatty matter before sending it out, and as this must be done while the oil is in a melted condition, this action of the oil on being melted is far from being desirable.—*Chem. Trade Jour.*

THE EQUINE BICYCLE.

THE growing custom of training and running very young colts; the danger of producing unsoundness while their joints, etc., are soft and immature; the importance of saving a few seconds in time to trotters,



and the fact that (like the last straw that broke the camel's back) an ounce of weight when the utmost strength is exerted is harder to overcome than the first 100 lb. at slow speed, has led to the study of some means of carrying the rider or driver with the least possible effort to the horse.

To carry weight is a constant struggle against the laws of gravitation; at each step or spring it is necessary for the horse to lift the rider's weight in addition to his own, and at just the time his entire strength is required to send him along, of course so much speed is lost.

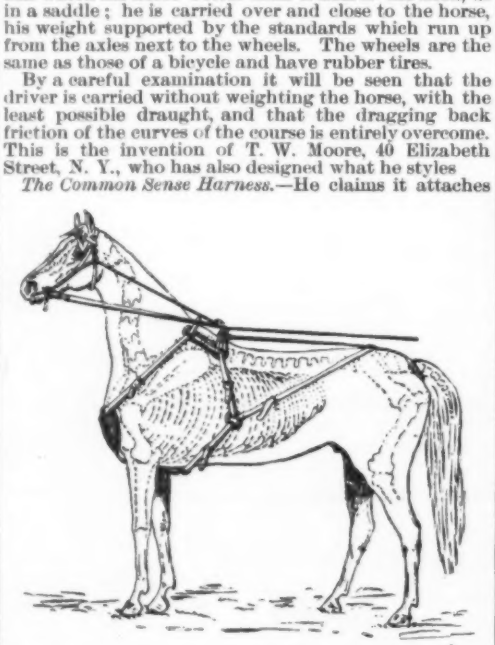
The equine bicycle not only relieves the horse of the weight of the rider, but runs so easily as hardly to impede his speed. In no other way yet known can the rider or driver be carried with so little tax upon the horse's strength or power of endurance.

The location of the wheels along the sides and flanks of the horse avoids the friction on the curves of the track. This bicycle does not swing a particle on the shortest curves. The reason is that the point of contact between the tire of the wheels and the track is opposite the propelling power. The greater the distance between the wheels and the sides of the horse, the greater the momentum of the swing and consequent drag on the curves. Sulkies sometimes jump several feet on sharp curves. In this the horse can be turned around in the space he stands on.

The seat is where the rider has perfect control of and can watch his horse better than if nearer the neck, as in a saddle; he is carried over and close to the horse, his weight supported by the standards which run up from the axles next to the wheels. The wheels are the same as those of a bicycle and have rubber tires.

By a careful examination it will be seen that the driver is carried without weighting the horse, with the least possible draught, and that the dragging back friction of the curves of the course is entirely overcome. This is the invention of T. W. Moore, 40 Elizabeth Street, N. Y., who has also designed what he styles

The Common Sense Harness.—He claims it attaches



the vehicle directly to the *frame of the body* of the horse, leaving the shoulders, quarters and legs entirely free, and their action unrestrained.

From the *forward* end of a small saddle over the withers straps run down each side the neck of the horse to a pad against his breast (which pad is arranged to vibrate with the motion of the chest at each step); from the lower end of this pad the tug passes between the fore legs, thence *up* the sides of the horse to a ring (or a tug buckle in double driving harness), attached to a strap which runs *down* to it from the *rear* end of the withers saddle. This brings the draught mostly on the withers, and entirely on the *solid frame of the body*, clearing the shoulder blades and joints, and allowing the fore legs their full sweep. From this ring at the sides the breeching extends to the crupper above the quarter joints, which leaves the quarters also free to stretch out to their utmost stride. In sulkies or wagons tugs may be used, but a short strap attaching the side ring to the shafts gives a firmer hold of the vehicle, therefore handles it more directly and easily.

The collar of the breast or Dutch harness in present use draws against the points of the shoulder joints. This strain upon them is unnatural, they tire sooner than the rest of the body, and it restrains the action of the fore legs. The hind legs are also tied up by the breeching binding against the quarters, the speed retarded, and the legs drawn together, often injuring the horse's gait, particularly of pullers. The legs are made to carry forward the body, and the joints to connect them to it. The true way is to attach the load to the body and let the limbs perform their functions.

SOFT WATER IN THE MANUFACTURE OF WOOLEN GOODS.

THE advantages of soft water, and its beneficial influence upon the wool fiber during the various stages of manufacture into cloth, as well as upon the appearance and feel of the ready goods, are familiar to every manufacturer. The endeavor is therefore made to have soft water at hand in sufficient quantity, or, where this is impossible, to clean the water by means of chemical and mechanical agents by precipitating the injurious mineral salts and other impurities it contains. The use of soft water, however, has been confined principally to those operations for which hard water could never be employed, or at least without great disadvantages. Such operations are the washing of the wool and the fabric, and the dyeing. The injurious effect of water containing lime or magnesia is strikingly manifested in these operations. The dyer notices it at once in the behavior of the mordanting or dye bath, and still more in the matching of colors on wool or on cloth, whether the water used is too hard or not. The wool washer and the fuller detect it quickly by the foam as well as the small flakes of lime soap floating in and upon the surface of the rinsing water, but most surely by the slippery feel and cloudy appearance of the wool or cloth.

Besides these operations, however, there are many others in the woolen industry in which the water, directly or indirectly, plays an important part, and in which very little attention is generally paid to the condition of the water. To this class belong the carbonizing, fulling and teaseling processes. Although the condition of the water is not of so great importance here as in washing and dyeing, it often makes a considerable difference whether the water is hard or soft.

The effect of the lime or magnesia salts in the water upon soap is well known. The latter decomposes almost instantaneously by its contact with these substances and forms a lime or magnesia soap, a product injurious in every way to the wool. Soap plays a twofold part in the fulling process: first, as detergent, that is, for loosening the dirt and oil, as well as for keeping open the serratures of the fiber, by which at the same time the felting process is promoted; and, secondly, as a protection to the fiber against friction and heat, the latter especially making it rough and brittle. In the former case the action is produced by the alkali with its cleansing effect; in the latter, by the fat, which keeps the fiber soft and pliable.

It is evident that substances having a decomposing effect upon the soap exert a detrimental influence upon the processes of cleansing and felting, and interfere with the preservation of the good qualities of the fiber. This coincides fully with all practical experience. As early as the starting of the fulling liquor, the solution of the soap in water, with hard water, a part of the soap is decomposed. This is at first of less consequence, there being always an excess of soap present. It causes a loss of soap, however, and besides this, the lime soap formed does not at all contribute to the improvement of the lye. As soon, however, as the cloth, which is either still wet from the preceding scouring or has been moistened with water, for instance, in the case of fine goods, which are dried again before fulling, is treated again with soap, it will be noticed at once that the latter continues to decompose. Instead of being soft and sappy, the cloth has a rough and dry feel, and instead of a light soap foam, a thin, watery, weak lye is obtained and absorbed by the cloth, and only after the repeated additions of soap, and after all hard constituents of the water have been absorbed, does the proper amount of sappiness and formation of foam commence. The cloth fulled with hard water will, as experience shows, run dry oftener, part with fibers more freely than it should, and require frequent additions of lye. Besides this, the lime soap precipitates upon the fiber and cannot entirely be removed, in spite of washing, making the cloth hard and slippery in feel.

If, in place of soap lye, water is occasionally poured in toward the end of the fulling process, because too much soap has already been added, the evil becomes still greater. Economy is never more dangerous than in just such a case. By fulling with hard water a much larger quantity of soap is needed, and the more it is stinted the harder and rougher becomes the cloth. Besides this, the more neutral and rich in fat is the soap, the more injurious will be the effect of hard water upon it, while soap of a more basic character decomposes less easily. The difference in the qualities of water explains why it is that a good fulling soap does not act at all times with the same good effect. Soap manufacturers, in view of the satisfactory results obtained by the use of their products in some instances, are often astonished when told that their soaps are useless, but the explanation of this is apparent.

Mills having only hard water at disposal should purify it not only for dyeing and washing, but also for fulling purposes. No water is more suitable for fulling than distilled or condensed water, as it comes from the steam engine, heating coils, and other steam apparatus. The good qualities of soap are best retained and promoted by this kind of water. The fabric remains moist much longer and does not require so much subsequent manipulation. It remains softer,

takes a closer felt, and is cleaned much more easily than with hard water. The water escaping from the engine, however, must first be conducted into a barrel and be drawn off from the bottom, while the oil from the lubrication of the steam cylinder is skimmed off or removed in some other manner. The water may also be filtered.

As regards the use of hard water in teaseling, as well as in the finishing of cloth generally, it may be accepted as universally true that the hardening constituents of the water have an injurious effect upon the wool fiber, and change it in a certain manner. It has not been determined whether this is due simply to mechanical or chemical action. One thing, however, is well established, that even in the prompt manipulation of the cloth in teaseling, not permitting it to lie for a length of time in a wet condition, the injurious effect of the use of hard water is apparent. The steady advance of the teaseling, and, as a result, the success of the process, is detrimentally affected. It can readily be seen that the teasel, instead of attacking and loosening the felt, which consists of wool fibers rendered hard by the water, must glide off more or less, and to the operator this is the simplest explanation of the circumstance that cloth treated with hard water never teasels as quickly, or becomes as open and soft, as when treated with soft water, which makes the fibers soft and pliable. Many a finisher has in certain cases taken refuge, as it were, in the use of warm condensation water, in order to have the cloth teasel soft and well.

The worst feature is that the injurious consequences are visible even on the dry cloth. Therefore, the fibers are not only hard in a wet condition, but retain this quality even when the cloth is dry. The injurious effect, of course, increases with the length of time during which the wool remained exposed to the influence of the water. The goods to be teaseled, therefore, should not remain long in a wet condition. Even when soft water is used there is a danger of hardening, and much more care, therefore, should be observed when using hard water. Experiments can be easily made to show the truth of this assertion. For instance, take two pieces of one lot of cloth, similar in all respects, teasel one immediately after scouring and let the other lie wet for a few days. The finisher will find a noticeable difference during teaseling in the behavior of the two pieces. Afterward, when both are dry, the difference will be still more apparent. He will find that the piece at once taken in hand will roughen up better, more readily open for nap, and remain softer in feel after drying. The fulling and teaseling departments of a mill should therefore always harmonize with each other, so that the fulled goods can at once be teaseled. In cases where the fulling department occasionally turns out more work than the teaseling room can treat with the same readiness, the drying of the pieces should not be neglected, for it is far better to keep them in a dry than in a wet condition. This applies especially to goods that are to remain soft and open.

After issuing from the teaseling room the cloth is exposed to the influence of the water, either in steam or wet lustering. In the manipulations which are to produce a lasting effect the use of soft water is indispensable. Medium hard water becomes soft by boiling, and need not be subjected to a chemical treatment to make it fit for use, but hard water should be purified previously. This is generally done by adding a little bran to the water and boiling for some time and then skimming it off. Water to be used for steam lustering becomes softer by repeated boilings, and is thus rendered more suitable for imparting a delicate and soft feel to the cloth.—*Industrial Record.*

RUBBER SUBSTITUTE.

THE term rubber substitute, in a manufacturing and commercial sense, is often misleading. In soft rubber its use is so small a proportion of the whole that the term addition would be strictly true.

In the hard rubber line there are many substitutes which have little or no rubber in them, and which are composed of various compounds, and placed upon the market by persons totally unconnected with the legitimate trade. In soft rubber, however, nearly every broker has his line of substitutes, which he carries along with his Paras, Centrals, and Africans. The substitute, if properly made, is not considered deleterious, and is very largely used. In clothing it is considered an improvement in the finish, making the goods soft and pleasant to the touch.

The skill in using it has received more attention in Europe than in America; and, in this way, poorer grades of rubber can be worked up at home better than is yet practicable there.

The number of mills making substitutes is computed to be twenty six, of which there are six in this country. The compounds have for their ingredients principally oil and chloride of sulphur.

The oil is, as a rule, either rape seed or linseed, preference being given to the former. There are other sorts composed of gun-cotton and devulcanized rubber, of devulcanized rubber and rape seed oil, and of resin and oil treated with chloride of sulphur. The difficulty in all these compounds is, at the proper time in manufacture, to free the compound of the sulphur in a way so as not to make it deleterious to the goods to be treated. In America ammonia is often used to neutralize the acid, which the foreigner claims to be injurious.

One difficulty in the use of a substitute is that the quality is not capable of a test until it is incorporated in the goods and goes into the consumer's hands.

The customer tests it, and, of course, does not know what is the matter. The goods are simply poor, and he changes his place of dealing, just as he may be particular or indifferent in the expenditure of his money. Place a half dozen white substitutes in a powder on a large sheet of paper. Take them separately without reference one to another, and a soft, mealy touch is the characteristic of each. If they were not side by side you could perceive no difference. But compare one with the other, and in the best grade there is a delicate, feathery touch, almost indescribable but very perceptible, which marks it from its fellows.

Keep them in jars for a length of time, and the poorer grades will get sodden and rot.—*India Rubber World.*

OBTAINING METALS BY ELECTROLYSIS.

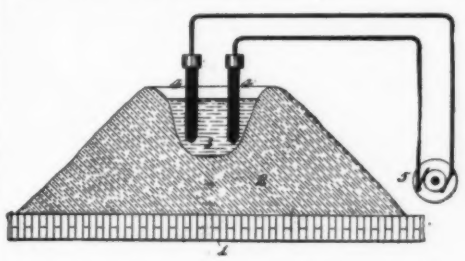
MR. CHARLES S. BRADLEY, of Yonkers, N. Y., is the author of a patented process which he describes as follows:

"My invention consists in employing a body or heap of the ore itself to constitute the vessel or cell in which the reduction takes place, which is not destroyed by the chemical action of the fused ore and the gas liberated, and which therefore admits of the process being perfectly continuous, nothing being required but the charging of fresh ore as fast as the reduction goes on, either from without or from the sides or walls of the heap itself.

"I will describe the process as applied in one particular case to the extraction of aluminum from its ore, cryolite.

"The accompanying drawing is sectional view of the pile of ore, with the electrodes in position in the basin and connected to a source of electric current.

"Upon a hearth 1, of brick or other suitable material, is piled a heap or body 2 of the ore, more or less pulverized, and a cavity or basin 3 is excavated in the top of the heap to contain the fused portion of the ore which is to be treated electrolytically. In order to fuse the ore at the start, I take two electrodes 4, composed of carbon or other suitable material and connected, respectively, to the two poles of a dynamo-electric machine 5 or other source of current, bring the said electrodes into contact, separate them sufficiently to produce an electric arc, and then thrust them down into the ore lying at the bottom of the cavity or basin, where the ore soon fuses by the heat of the arc and becomes a conducting electrolyte, through which the current from the electrodes continues to flow. The arc of course ceases to exist as soon as there is a conducting liquid—the fused ore—between the electrodes, and the passage of the current then takes place through the fused ore by conduction and the heat is produced as it is in an incandescent lamp. The arc is merely used to melt the ore in the beginning, and the ore is kept melted by incandescence, so to speak, the metallic aluminum being gradually deposited at the cathode, and the fluorine gas being set free at the anode so long as the ore is maintained in a state of fusion. As soon as the action is properly started, the electrodes should be moved a little farther apart, in order that the metal set free at the cathode shall not form a short circuit be-



tween the electrodes or be attacked by the fluorine set free at the anode. I have spoken several times of fluorine being set free, although I am aware that it is considered to be almost impossible to isolate that element. I use the term 'fluorine' merely for convenience, meaning thereby whatever is set free at the anode, which may be fluorine or some compound of fluorine with the substance composing the anode, moisture of the air, etc. As a matter of fact, when the process is worked fumes arise at the anode; but the anode is not attacked or eaten away very rapidly, provided it is made of pure carbon, such as gas retort carbon, which I prefer to carbon containing silica or alumina."

ELECTRIC POWER DISTRIBUTION.*

By H. C. SPAULDING.

THE commercial possibility of transmitting power for comparatively long distances by electrical means, when the losses attendant upon such transmission by any other system would be prohibitory, is sufficiently well known and acknowledged at the present time to call for no extended comment. Curiously enough, our friends on the other side of the Atlantic are far in advance of us in the utilization of natural energy for lighting and power service, although the number of water power installations is rapidly increasing in our Western States and Territories, where the high cost of fuel would naturally bring about such a result. In Switzerland alone there are already upward of 200 electric power stations utilizing water power for operating lights and motors over extended areas, while possibly the best known illustrations of such service in our own country are at Spokane Falls and Aspen.

It is the purpose of this paper, however, to separate, so far as possible, the closely allied topics of power transmission and power distribution, electrically considered, and to treat the latter principally in the light of its adaptability to manufacturing and constructing operations. It is accordingly immaterial, so far as the scope of this article is concerned, whether we are to utilize a water privilege 10 or 15 miles away, and possibly so situated between high and precipitous banks as to render it impossible to locate our manufacturing plant there, or to distribute the power furnished by a steam plant in the immediate vicinity, which may, however, be so isolated as to reduce fire risks to a minimum while taking advantage of the most economical situation for coal and water supply. Let us assume, therefore, that we are provided with an electric current supply sufficient in quantity to operate whatever apparatus we may wish to connect and of sufficiently low pressure or "voltage" to allay any fears of personal injury on the part of employes.

The "main shafting" naturally demands our first attention, and if the buildings are of more than one story, the advisability of dividing the plant into sections, each one of which may be started and stopped independently of any other, and without belt towers or belt holes (those efficient dust and fire conveyers), is evident to the most superficial observer; while in a single story building such subdivision reduces to a minimum the friction of lines of shafting, run most of the time, it may be, for the operation of only two or three machines. Engineers will appreciate fully the tales the indicator will tell, in nine out of ten of our larger manufacturing plants, of the power devoted to revolving the immense "main shaft" and in transmitting power from one line of shafting to another when not a single machine tool is in operation. While it is not advisable to run any but the largest tools by separate motors, it will usually be found possible to group machines in systems requiring from 10 horse power upward, and so arranged that the average of power required will not vary between wide limits, and such variation will not occur suddenly. We can then connect with the shafting for each group a properly designed motor, which may be started and stopped almost instantaneously, and, if desired, allowing of delicate adjustment in speed.

A motor operating various classes of apparatus can be placed on the floor precisely as a small engine would be, but requires no special foundations (owing to the absence of reciprocating motion and consequent pound), and may be belted to the shafting in the ordinary way. When the shafting is more than 10 or 12 ft. from the floor it will usually be found advisable to provide a light platform on which to stand when inspecting or oiling.

One motor of 15 horse power capacity operates two Pond planers of 84 in. and 72 in. respectively, one 5 ft. Warren radial drill, also a large double grinder; and is one of a system comprising more than 20 separate motors operating at distances varying from 200 to 1,400 ft. from the central engine and generator. Another motor in the same factory and of the same size (15 horse power) operates two 36 in. planers, two 32 in. planers, six 32 in. lathes, one 42 in. lathe, one 48 in. chucking machine, four 5 ft. Prentice radial drills, and a large double grinder.

The application of motors to the operation of one or two machines by means of countershafting is of course a small matter and calls for no special comment.

The increase during the past few years in the size of construction parts and machine tools has called for a corresponding increase in the power of devices for handling them, as demonstrated by the number of traveling cranes put in by the larger manufacturing plants. The friction losses in transmission by square shafts or other prevailing methods are excessive, and the possibility of operating the heaviest traveling cranes without mechanical connection between the crane trolley and the source of power, as provided by electrical means, appeals at once to the engineer, provided the losses in transforming from mechanical to electrical energy and back again are not excessive. The following data concerning a 30 ton crane, which was built by the Morgan Engineering Co., and equipped with Thomson-Houston motors, may be of interest.

Three motors are used, one of 3 horse power capacity for cross travel, and two of 10 horse power capacity for hoisting and longitudinal travel respectively. The three movements may be obtained in any combination of direction and speed, as each motor is provided with a separate controller. The motors are built for 220 volts, and receive the current from two trolley wires running one on either side of the main floor, resting on insulators, a copper brush attached to either end of the bridge lifting the wire as it passes along, somewhat as in the method employed by cable cars in lifting their cables.

The motors on the crane trolley receive their current through carbon brushes sliding along copper strips placed on the inside of the bridge. The total longitudinal travel of the crane is 165 ft.; length of bridge between rails, 27 ft. 2 in. Total lifting space, 21¼ ft. A "solenoid" brake is provided, which holds the hoisting gear automatically and instantaneously whenever the supply of current is shut off from the hoisting motor.

The extreme ease of operation, and the fact that the expenditure of power is almost exactly proportional to the work accomplished, and ceases absolutely when the crane is not in motion, are important features of this class of apparatus.

By a simple and ingenious application of electro-magnetic principles, a load of almost five tons is held suspended by the attractive force of a magnet weighing only one-tenth of that amount. Such a device may often be used to great advantage in handling pig iron, castings, boiler plates, etc., owing to the speed with which the operation of "picking up" and "letting go" may be accomplished. A simple "make and break" switch answers for a controlling device, and may be located either on the magnet itself or at any desired point. By a simple device the quantity of current and proportional strength of the magnet may be varied at will by the operator, so that in handling small pieces, such as bolts, rivets, fittings, etc., only the desired amount may be lifted.

One of the most useful applications of electric motors is in connection with hoisting apparatus of various kinds, including passenger and freight elevators. A power hoist is often required in a storehouse or shipping room at some distance from line shafting, which it would be expensive to extend, while steam piping means possible injury to stock from frozen or leaky pipes, and a small steam plant means increased insurance. Under these circumstances the electric hoist is available, taking its power from a pair of wires which may be carried over and through buildings and around corners with a minimum of space, care, and expense, and a maximum of convenience, economy, and safety. A portable hoist of 15 horse power capacity is designed especially for dock work and fitted with a double rope for unloading a steamer's cargo.

These hoists are furnished with a few feet of flexible cable, and may be connected in a few seconds with "service plugs" located on various parts of the wharf, the current being taken either from the lighting wires on steamer or shore, or, better, from a special power circuit, if such be available. Hoists of this kind may be advantageously used for building operations, and are appreciated on account of the absence of smoke and noise.

The earlier applications of electricity to elevator service were not specially successful, except for slow speeds, as it was not for some time considered feasible to start, stop and reverse the motor itself, thus imposing the disadvantages inherent in "open and crossed belt" machines upon all electric elevator installations. The only practical method of using motors for high-speed passenger work was for some time, therefore, in operating the pumps of hydraulic systems, but of late the de-

* Presented at the New York meeting of the American Society of Mechanical Engineers.

velopment of quick controlling and reversing apparatus, with special types of motors, has made possible results fully equal in smoothness of operations to the best hydraulic practice, while the running expense is usually considerably less. Designs are in use for a double drum freight or slow passenger type of machine, in which the movements of the apparatus are controlled entirely by electric means, the armature shaft of the motor being run in either direction at will, and at any desired speed.

In an improved high speed passenger machine now in operation in a large business block in Boston, the controlling mechanism is entirely in the car and operating through flexible cables. Automatic brakes are provided, which are thrown into operation by the shutting off of the current, while the usual safety devices against over-travel and breakage are present, with others of a purely electrical nature.

The enormous areas required by many of our industrial concerns for carrying on the various processes of manufacture to the best advantage necessitate new and improved methods for the transportation of fuel, supplies, and material in various stages of treatment from one part of the plant to another; and here again the invisible agent electricity offers its services in a safe, compact, and effective form.

While much of the electric locomotive truck service is naturally dependent upon local conditions and the amount of material to be carried, the saving over other methods has been entirely satisfactory to the score or more of corporations which have adopted it up to the present time. Small electric trucks are applied to various lines of mill work, the motors sometimes being of only three horse power capacity, and using the regular lighting current. A larger size is suitable not only for general yard trucking, but having sufficient power to act as a yard shifter for freight cars, being fully equipped with extra heavy brakes, drawbars, and buffers for this purpose.

Among the numerous auxiliary uses to which electric apparatus may be put is that of pumping, either for boiler feed or general supply purposes. A number of automatic switches are now on the market, by means of which an electric pump may be automatically started or stopped by a change of water level either in a gravity or pressure tank, a feature susceptible of numerous adaptations as suggested by circumstances.

An objection sometimes offered to the adoption of electric apparatus is that, owing to the "youth of the art," the types of machines now built and on the market will in a few years be obsolete, like a coat outgrown though not outworn, so that the necessary investment is an unwise one on the part of the purchaser. This view seems to the writer not fully warranted, in the light of recent developments in electro-dynamics, since the efficiency of this class of machinery is now so high as to direct the ingenuity of electric engineers rather to the invention and improvement of auxiliary apparatus for controlling, measuring, and protecting the currents produced, than to the invention of new apparatus for their production.

The claim may now fairly be made also that the various "gauges" of the electric systems have been brought to standard, and that a piece of apparatus bought of any reliable company is adapted for use as well in conjunction with apparatus produced by another, and it may be competing, concern, provided the two systems are of the same general nature. This is as necessary as that there should be one standard of measurement for engineering supplies of any kind, arbitrary, to be sure, but binding by courtesy throughout the engineering fraternity.

In conclusion, it is interesting to note the tendency to incorporate electric motors with various classes of machinery, thus forming complete mechanical units. It is to-day possible, for example, to equip a printing or publishing house equal in completeness to any now existing, without using a hanger, line shaft or belt, each press being complete in itself as far as mechanical connection with the source of power is concerned, the entire transmission being accomplished by means of concealed wires.

The same is true of almost every line of industry, while the general application to naval practice is apparently a matter of the immediate future.

THE INVISIBLE JOURNEY OF A GLASS OF WINE.

BEING given an ordinary glass half full of wine, which everybody can examine closely, and a hat situated at a distance, the question is to cover the glass with a piece of paper, and thence to send it invisibly into the hat.

A small piece of wood or paper that a spectator has put in the wine, or any mark whatever that has been made upon the glass, will permit of verifying the fact that it is really the same glass that was first exhibited, and that is afterward found in the hat.

In order to perform this trick, it is necessary to have one of those double glasses (Fig. 4) that can be easily obtained in variety stores, and which contain between their double sides a red liquid that has been introduced through the foot of the glass, which is hollow. A small cork, *b*, which is absolutely invisible if it is not examined very closely, is inserted and withdrawn at will in order to change the liquid; but, for our trick, there is no occasion to occupy ourselves with these details. This double glass is kept concealed until the moment arrives for using it.

A second glass—this is a simple one (Fig. 4 B) and of the same appearance as the other—is filled with wine, in the presence of the spectators, to a level equal to that reached by the red liquid in the double glass.

The prestidigitator, after exhibiting the interior of the hat so as to allow it to be seen that the latter is empty, introduces into it, while he turns his back to the spectators, the double glass which he had concealed under his arm, and which can be handled without any fear of spilling the liquid that it contains. The hat is then placed upon the table.

Afterward, taking the simple glass in his hands, the prestidigitator asks the spectators whether he shall make it pass visibly or invisibly into the hat. As a usual thing, suggestions are divided, and so, in order to please everybody, the glass is first put ostensibly into the hat and then immediately taken out, that, at least, is what is thought by the spectators, who are very ready to laugh at the little hoax played upon those who perhaps expected to see the glass carried through the air upon the wings of the wind. But the prestidigitator has taken care to leave the simple glass in the hat and to take out, in place of it, the double glass, which he presently spirits away with ease by the following process. The glass having been placed upon the table, he covers it with a square piece of strong paper, which he folds around it in such a way as to make it follow its contours and completely conceal it (Fig. 1). This paper, which must be very stiff, as well as strong, afterward preserves the form upon which, so to speak, it has been moulded, although it is no longer supported by the glass, which has been allowed to fall

TRICK PERFORMED WITH A GLASS OF WINE.

behind the table into a sort of pocket of canvas, or into a box lined with silk waste, arranged to this effect (Fig. 2).

The prestidigitator, having thus got rid of the glass, walks toward the spectators delicately pressing the top of the paper between the thumb and forefinger of the left hand, as if he still held the glass in the paper, and the foot of which seems to be supported by the right hand. A spectator is then invited to take the glass with the paper, and care is taken to advise him not to allow the wine to run up his sleeves. He then stretches out his hands; but at the same instant, the paper, suddenly crumpled into a ball, is thrown into the air, and the glass of wine has passed invisibly into the hat.—*La Nature.*

IMITATION ICE.

ROLLER skating appears to be perennially popular, nevertheless, edge skating is infinitely preferable when it can be had. Londoners have now been provided with as near an approach to real skating as is possible in the shape of the "Crystal Ice Rink," opened lately at St. Stephen's Hall, adjacent to the Westminster Aquarium. The skating surface is a composition which Dr. Calantarients, of Scarborough, invented some time ago. It has been experimented with in that town, and found satisfactory. The surface for skating is prepared by pouring on an asphalt flooring successive layers of water and certain salts in a heated state, each layer being allowed to cool and crystallize before another is applied. The top layer, it is estimated, will be able to withstand the wear and tear of a single week, and it will then have to be renewed. By the spectator the noiselessness of the new rink will be much appreciated,

THE CRYSTAL ICE RINK, LONDON.

while to the skater the employment of steel skates instead of rollers will be a great recommendation. All that seems required is that there should be somewhat less friction on the surface. A band plays daily, and examples of figure-skating are given by Professor Stiegert of Germany.—*Daily Graphic.*

HOW WE TREAT THE CHINESE.

By W. F. GRAY.

ATROCIOUS as the crimes were described recently, the next to be outlined, though it involves only the loss of two lives, may well be considered as surpassing it, since it occurred in a supposedly civilized community, whose people had full knowledge of what was about to occur, and yet not one of whom would so much as lift his hand to prevent a terror-stricken, shrieking, begging, fellow mortal from being literally and absolutely hacked to pieces before their eyes.

Over on the eastern slope of the Sierra is the town of Bridgeport, the seat of government of Mono County. For many years a Chinaman named Ah Tia had been in business there, and he had built up a respectable trade with both whites and Indians, there being quite a number of these latter resident in the vicinity, while the Walker Lake Reservation is but a few miles distant. The Chinese, like the Indians, are inveterate gamblers, and Ah Tia used frequently to have poker parties in his store after nightfall. Some time in May last a well known Indian, rejoicing in the appropriate name of Poker Tom, got into a game with Ah Tia, and found the wily celestial too sharp for him. They played until well into the night, until all the other Indians had gone to their camp. According to the Chinaman's subsequent statement, his Indian antagonist, after losing all his money, became angry and demanded its return. This was refused, and then Tom attacked Ah Tia and tried to force him to give up the money. A desperate fight ensued, which finally resulted in the Chinaman getting hold of a knife and letting his antagonist's life blood out on the floor. Terribly alarmed, Tia threw the Indian's body into the river, washed up the blood stains as best he could, and then went to bed.

When asked where Tom was next day, Ah Tia denied all knowledge of him, and it was for a while supposed that he had gone away to some of the Indian settlements in the mountains. A few weeks later, however, it was learned that he had not been seen at any of them, and soon thereafter a portion of a human body was discovered in the river, which was at once said by the Indians to be Poker Tom's remains. Remembering that he and Ah Tia had been seen playing poker together, the Indians immediately charged the Chinaman with the murder of their companion, and threatened to revenge themselves in Indian (and civilized) fashion by killing him too.

In fear for his life, Ah Tia went to the sheriff and begged to be locked up. This was done without any charge having been preferred; but at the inquest over the remains found in the river it was developed that Ah Tia had confessed to killing Poker Tom, and he was accordingly arrested on a charge of murder and retained in jail, where he already was. Several prominent citizens, including the president of the board of supervisors, now publicly announced that they did not believe in putting the county to the expense of trying the Chinaman, but thought he ought to be turned over to the Indians to be punished. They even went so far as to encourage the Indians to capture Ah Tia and kill him. This talk was open and above board, and no secret was made of it. The Indians naturally became greatly excited, and the sheriff put an extra guard at the jail to prevent surprise. But when a responsible and law-abiding citizen went to him privately and offered to take the Chinaman out of town and carry him to another place where he would be safer, the proffer was curtly refused. A date was set for the preliminary examination, but no complaint was made out, and when a citizen brought this to the attention of a prominent officer he was told to "shut up, or he would get a dose himself."

Everything points to the conclusion that the authorities themselves believed it would be cheaper to let the Indians deal with the Chinaman than to put the county to the expense of a trial. At all events, when the examination came off the *sheriff went home and went to bed*, leaving the prisoner in charge of a constable. The trial was held with closed doors, but just before it com-

menced the president of the supervisors was again heard to urge the justice to "let the Indians have the —— Chinaman." No complaint having been filed, and the witnesses refusing to identify the remains as those of Poker Tom, the justice in a few minutes ordered Tia to be discharged. Several Indians were on guard at the door of the court room, and no sooner had the justice turned Ah Tia loose than the constable walked to the door, threw it open, and announced that he had got through with the Chinaman. At the same time another "leading citizen," who was standing by, told the Indians to go in and get the Chinaman. Ah Tia understood perfectly well that his discharge from custody meant an awful death. He fell on his knees, grasped the judge by the legs and begged him for protection. In pitiful accents he said he knew the Indians would cut him to pieces, and besought the justice to send him back to jail. But a stolid refusal met his tearful prayer; and then came in two Indians armed with revolvers and clad in the uniform of the United States Indian police corps. They tore the Chinaman's grasp from the judge's knees and dragged him out into the street. There they were joined by five of their comrades, and Ah Tia was hurried down the main street of the town. As several witnesses have since testified, one white man with any "sand" and a good revolver could have stood off the whole crowd of Indians. But it was only a Chinaman after all; and so the red devils were allowed to take their victim to his doom. Ah Tia called to the people along the street to save him; but they turned a deaf ear to his entreaties, though they knew full well what his fate was to be. Arrived at an open spot in the outskirts of the town, the gang halted, knives were drawn, and amid the heartrending shrieks of their victim and the demoniac howlings of his murderers, the Chinaman was literally disemboweled and hacked to pieces by the incarnate fiends who had been egged on to their bloody deed by white men. It was necessary to use shovels in gathering up the ghastly scraps of humanity that were scattered about the scene of the butchery.

This is a short summary made by your correspondent from a big budget of affidavits telling in detail the incidents of the whole shameful affair, which were obtained from eye witnesses by the agents of the Chinese consul in this city.

These affidavits have been translated and forwarded to the home government at Peking. That they will be made the basis of a demand for indemnity is certain; that they ought likewise to lay the foundation for the punishment of the parties concerned in this horrible affair is equally certain.

Again the scene shifts, and again we come still nearer home. This time it is at Vallejo, and the date is the 4th of July last. A crowd of hoodlums celebrated their independence of all law by bombarding houses in the Chinese quarter with fireworks. The Chinamen shut up their stores and houses, lock the doors and windows, put out lights, and cower in fear of possible disaster. That disaster soon comes. The fireworks of the hoodlums set fire to a house, and it is quickly in flames. In the excitement stores are robbed, Chinese maltreated, and a riot prevails. Finally the flames are extinguished, and in the ashes of his dwelling a Chinaman finds the charred and blackened remains of his infant daughter. As he regards it with tears streaming from his eyes, a fiendish hoodlum happens to come up. He sees the inanimate object lying on the ground, and with a devilish shout to his companions he kicks it toward them, a veritable human football. Maddened to desperation, the bereaved father springs upon the heartless wretch and almost beats the beastly life out of him. Pity that he had not completed the job!

The authorities are at first unable to find any who took part in the affair. Then, urged on by white friends of the Chinese, they make a few arrests, there is a half-hearted prosecution, and finally the outrage goes unpunished.

This story, too, in full detail, has been communicated to the home government. Is there any reasonable ground to doubt that it, too, will be made the basis of a demand for indemnity?

Within the past six weeks or two months there has been what looks very like an organized movement for the expulsion of the Chinese from the various towns along the line of the Southern Pacific Railroad in the San Joaquin Valley. At Madera the whole of the Chinese settlement was burned at midnight by incendiaries, sixty houses being destroyed, and over a hundred people made homeless, besides losing all their personal belongings.

At Selma a party of white men went at night to the building occupied by a gang of Chinese railroad employes and ordered them to leave the place. The railroad company made up a train and carried the Chinamen to a place of safety, after which the building occupied by them was set on fire and destroyed, the pumps at the railroad tank house having been disabled so that no water was available to extinguish the flames.

At Delano the same action was repeated, the Chinese being awakened at midnight and forced to dress themselves and hasten away, under threats of violence should they remain.

At Tagus, near Tulare City, a gang of white men visited the camp of a party of Chinese railroad graders, assaulted them with clubs and pistols, drove them away, and then ransacked the tents, stealing all the money and valuables they could find.

At Pixley the Chinese section hands were driven away during the night (it is always midnight when these attacks are made), and about the same time a large number employed in some gravel pits near Tulare were also driven off, the railroad company carrying them to other points by special train in order to save their lives.

At Borden two section houses filled with sleeping Chinese were set on fire early in the morning, and the occupants had barely time to escape with their lives, losing all their clothes and personal property in the flames. The men who set fire to these buildings were seen, but the Chinese were too much frightened to attempt their arrest.

So far as the authorities are concerned, there are no reports that steps of any kind have been taken either to prevent these outrages or to punish those guilty of them. The local newspapers have in some cases actually encouraged the men who have committed the crimes related, while others have tacitly done so, and in no case has there been any expression of condemnation.

The only ground upon which the outrages have been justified has been the assertion that the Chinese had displaced white men, and the latter were starving because of having been deprived of employment. Let us look into this a little.

Fresno County, where most of the outrages have occurred, is the center of the raisin industry in this State. While the season is at its height, several thousand hands are required in gathering grapes, drying them, and packing the raisins. This work must be done quickly after the grapes ripen, or great loss will result. This season it was given out that the raisin growers would employ white help, and the wages were established at $1.75 a day. But when the grapes were mature and it became necessary to gather them, the growers found that they could not depend upon their white help. Men would work a few days, and then demand their pay and go off on a drunk. If a vineyardist needed fifty to one hundred men, and went to town after them, he had to chase around all day to get a few hands, while by going to a Chinese "boss" he could obtain all the help he wanted at fifteen minutes' notice. The Chinese were already organized into squads, with cooks, utensils, provisions, etc.; and all that was necessary was to take them to the vineyards and put them to work, where they would remain until the close of the season. The whites, on the other hand, were unorganized; it was necessary to provide everything for them, and the greater proportion would leave after having earned a few dollars.

Now the raisin is a fruit that needs incessant care and steady attention, and spasmodic labor such as this leads to great loss. In sheer self-protection, therefore, and while acknowledging that they would far rather employ white help, the vineyardists were forced to put the Chinese to work. The displaced white men accordingly took revenge in the manner indicated, by assaulting and driving away Chinese living in companies at points along the railroad. They tried the same game with some of the vineyard employes, but were met with such a display of weapons by the white employers that they became quickly discouraged, and confined their subsequent efforts to brave midnight attacks upon sleeping Chinese.

In the majority of instances, the leading newspapers of the large cities have paid no attention to these outrages. Only the most meager reports have been telegraphed, even when any attention whatever was paid to them, and it is only with great difficulty that the facts can be learned. But every statement made in the foregoing can be substantiated, and if the truth were known, undoubtedly a far worse state of affairs could be shown.—*The Independent.*

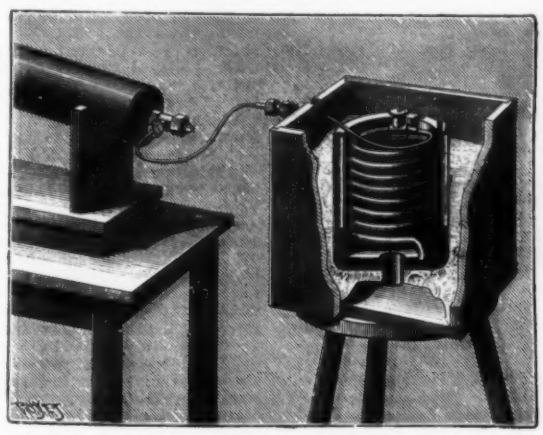
CAILLETET'S CRYOGEN.

THE production of high temperatures has furnished chemists, physicists, and manufacturers very important resources that have aided in the manufacture of useful products or in the performance of instructive experiments. The production of cold, or of low temperatures, offers no less interest than does the production of heat. An apparatus that permits of easily producing an intense degree of coldness may be considered as one of the most useful of instruments in laboratories and manufactories. An apparatus of this kind, called a cryogen, has recently been devised by Mr. L. Cailletet, the learned academician whose admirable labors are known to our readers.

We shall here recall what have been the principal methods used for obtaining low temperatures. The oldest consist in the use of freezing mixtures, such as cracked ice and sea salt, sulphate of soda and hydrochloric acid, nitrate of ammonia and water, etc. The more recent ones consist in the evaporation of liquefied gases or volatile substances, such as liquid ammonia, liquid sulphurous acid, and chloride of methyl. Liquid ethylene and formene have been used for the liquefaction of oxygen and the air.

In his new apparatus, Mr. Cailletet uses liquid carbonic acid, such as is now manufactured industrially, and quickly obtains a low temperature by the expansion of the liquefied gas.

The apparatus, which we represent herewith as constructed by Mr. Ducretet, consists of two concentric vessels of nickel plated copper, having an interval of a few centimeters between them. A worm, likewise of copper, is placed in the inner vessel. It is about four meters in length and fifteen millimeters in diameter. It is provided at the upper extremity with a cock, and terminates at the lower extremity in the annular space between the two vessels. When one wishes to operate, the inner vessel is filled with alcohol, which is to serve as a refrigerating bath for the experiments to be made; then the worm is put in communication with a cylinder of liquid carbonic acid (shown to the left of the figure). The cock of this cylinder having been turned full on, the liquid reaches the cock of the worm, which is opened but slightly. The vaporization and expansion of the carbonic acid lead to its congelation in the form of snow. The flakes, coming into contact with the sides of the worm, quickly change back to the gaseous state, and, in doing so, produce an intense coldness. In the annular space are placed fragments of sponge saturated with alcohol. Any snow that may have passed through the worm without vaporizing dissolves in the alcohol, and the refrigeration resulting therefrom completes the lowering of the temperature.



MR. CAILLETET'S CRYOGEN.

The entire apparatus is inclosed in a box packed with silk waste, and provided with a cover lined with wool, in order to prevent radiation. Several orifices in the cover allow of the passage of a stirring rod, thermometers, etc.

The cryogen is capable of producing in a short time a temperature of about —70 deg. When the circulation of the carbonic acid gas is arrested, the apparatus, surrounded with its protective jackets, heats again only with extreme slowness.

In one experiment, made with every necessary precaution, it was observed that, at the end of nine hours, the temperature of the alcohol had risen only from —70 deg. to —22 deg. It will be understood, then, that by introducing a very small quantity of liquid carbonic acid from time to time, a sensibly constant and very low temperature may be maintained indefinitely.

In several experiments it was found that, in order to bring the apparatus with its three liters of alcohol to —70 deg., it sufficed to use about from 2 to 2½ kilogrammes of liquid carbonic acid.

Mr. Cailletet's cryogen, which we have described above from a communication concerning the apparatus made to the French Society of Physics, may be considered as realizing for cold what the laboratory gas furnace does for heat. It will certainly be called upon to render important services.—*La Nature.*

CONSTITUENTS OF METEORIC IRON.

THE *Annalen des k. k. naturh. Hofmuseums*, No. 2 of vol. vi., contains a further contribution by E. Cohen and E. Weinschenk to their interesting studies on meteoric irons.

By treating comparatively large masses in the cold with very dilute hydrochloric acid (1 in 20), so that the process of solution was very slow, in some cases extending to several months, a residue is left from which it was found possible to isolate several more or less definite compounds, distinct from the freely soluble main mass of the meteorite.

It is in the portion insoluble in the highly dilute acid, which in some cases amounts to no more than 5 per cent. of the whole, that the main interest in analytical work on meteoric irons centers. The patience and care involved in the separation of its various constituents often find their reward in some interesting discovery. As a typical example of the constituents into which a meteorite may be separated by this treatment with dilute acid, it will suffice to quote the percentage numbers obtained in the case of a slice of the Magura iron. They are as follows:

Nickel iron which passed into solution	92·67 per cent.
Cohenite	4·00 "
Tænite + jagged fragments	0·13 "
Schreibersite	0·09 "
Tænite + cohenite	2·93 "
Non-magnetic residue	0·18 "

In most meteoric irons the soluble portion consists to a large extent of a nickel iron kamacite, which mainly constitutes the broad layers of the Widmanstatten figures seen on an etched polished surface. The authors are of opinion, from a comparison of various analyses, that this alloy has a constant composition represented by the formula $Fe_{11}Ni$.

Cohenite, which occurs in very brittle tin white crystals, has at present been only found in the Magura iron. It was analyzed and described in a previous paper by Dr. Weinschenk, who found it to consist of a definite carbide of iron, nickel, and cobalt, having the composition represented by the formula $(FeNiCo)_3C$. Very similar crystals in the Wichita iron were found to have the composition represented by the formula $(FeNiCo)_4C$, analogous to the well known spiegeleisen, Fe_4C. Cohenite corresponds to the carbide Fe_3C, which separates out in crystals when cast iron is slowly cooled between 600° and 700°. Many points of resemblance such as this between meteoric and ordinary cast iron appear to show that the conditions as regards temperature, etc., during their production must have been very similar in the two cases.

Tænite, occurring usually in thin silver-white lamellæ of great toughness between the broader layers of kamacite, is a nickel iron, of which there appear to be two varieties, containing respectively about 65 and 73 per cent. of iron. Further analyses, however, are necessary

in order to determine its true composition. The jagged and angular fragments of iron black color were analyzed, and found to consist of a nickel iron containing about 7 per cent. of nickel, and were thus in all probability identical with kamacite.

The phosphor-nickel-iron schreibersite is generally found in large tabular crystals of tin white color. The new analyses show that its composition may be represented by the formula $(FeNiCo)_3P$. In some meteorites a phosphor-nickel-iron occurring in needles is found. This is the so-called rhabdite of Rose. Whether it is identical or not with schreibersite has not yet been decided, owing to the difficulty of obtaining pure material. A non-magnetic residue, consisting chiefly of transparent grains, the authors find is common in greater or less amount to most meteoric irons. In such residues a great variety of minerals have been identified with more or less certainty, such as diamond, cliftonite (a graphitic pseudomorph after diamond), quartz, tridymite, chromite, cordierite, garnet, corundum, pyroxenes, both rhombic and monoclinic, etc.

The aim of the authors in the present investigation was to answer the following questions: How widely distributed is cohenite? Are schreibersite and rhabdite definite compounds? Has kamacite a constant composition? Has tænite always the same physical and chemical properties? What is the composition of the jagged fragments so generally left undissolved after treatment of meteoric irons with dilute hydrochloric acid? How widely distributed are the transparent grains, as well as the diamond, cliftonite, etc.?

Unfortunately, owing to the fact that the present joint investigation had to be brought to a somewhat premature conclusion, a definite answer to all of these questions could not be given. We may, however, expect soon to hear more on the points still left undecided, as the promise is made that the gaps in the present investigation shall be filled up as soon as possible.—*G. T. P., Nature.*

ON THE MASS AND BRIGHTNESS OF BINARY STARS.

By J. E. GORE, F.R.A.S.

THE orbit of a binary star having been computed, and its distance from the earth determined, it is easy to calculate the combined mass of the components in terms of the sun's mass. We can also compare the brightness of the star with that of the sun, for as the brightness decreases as the square of the distance, we can compute how much the sun's light would be reduced if removed to the distance of the star. Photometric comparisons have shown that the sun's stellar magnitude is about —25·5 on a scale of which the "light ratio" is 2·512. In other words, the sun is 25½ magnitudes brighter than a star of the zero magnitude, or 26½ magnitudes brighter than an average star of the first magnitude, like Altair or Spika. The parallax of some of the binary stars has been ascertained, and although the results found are perhaps in some cases of rather doubtful value, an examination of the mass and brightness indicated by the most careful measures of the distance may prove of interest to the reader.

We will take the stars in order of right ascension:

1. η Cassiopeiæ.—For this well known binary star a parallax of 0·3743 has been found by Schweizer and Socoloff. Several orbits have been computed, none of which are quite satisfactory, but assuming Gruber's period of 195·235 years, and semi-axis major of 8·639", I find the mass of the system equal to 0·32 of the sun's mass. The star was measured 3·41 magnitude with the photometer at Oxford, and 3·64 at Harvard. We may, therefore, assume its magnitude at 3·5. Taking the sun's stellar magnitude at —25·5, I find that if placed at the distance indicated by the above parallax the sun would be reduced to a star of magnitude 3·2, or only slightly brighter than η Cassiopeiæ. As the companion is only 7½ magnitude, it will not appreciably affect the light of the star, and as the spectrum is of the second or solar type, it should be fairly comparable with the sun. If the mass were equal to that of the sun, the parallax would be 0·256", and at this distance the sun would be reduced to a 4th magnitude star. Struve found a parallax of 0·154". Its comparatively large proper motion of about 1·2" per annum would indicate comparative proximity to our system.

2. 40 Eridani.—The binary companion of this triple star is of about the 9th magnitude, and is probably physically connected with the bright star, as all three have a common proper motion. A parallax of 0·223" has been found by Professor Asaph Hall. This, combined with the orbit computed for the binary pair by the present writer, gives a mass equal to the sun's mass —a result which is remarkable, for the sun, placed at the distance indicated by the parallax, would shine as a star of 4·3 magnitude, or about the brightness of the principal star of 40 Eridani. This result implies that the sun is about 76 times brighter than the binary pair. Owing to the faintness of the binary star, the character of its spectrum has not been determined. Computed by a well-known formula, its "relative brightness" is very small, but only one orbit has yet been computed, and this will require revision when further measures are available. The proper motion of the system is very large, about 4·1" per annum.

3. Sirius.—The great brilliancy of this star—the brightest in the heavens—naturally suggests a sun of great size. Recent investigations do not, however, favor this idea. Assuming a parallax of 0·39" (about a mean of the results found by Elkin and Gill) and the elements of the orbit computed by the writers, the mass of the system would be 3·114 times the mass of the sun. Placed at the distance of Sirius, the sun would be reduced to a star of 3·1 magnitude. As Sirius is about one magnitude brighter than the zero magnitude, it follows that it is about four magnitudes, or about forty times brighter than the sun would be in the same position. Were it of the same density and brightness as the sun, the mass found above would indicate that its diameter should be 1·463 the solar diameter, and its brightness 2·1334 the solar brightness. The spectrum is, however, of the first type, and the star is, therefore, not comparable with the sun in brilliancy. The result would indicate that stars of the first or Sirian type are intrinsically brighter than the sun.*

* Or that they are of less density than our sun.—A. C. RANYARD.

4. Castor.—Assuming a parallax of 0·198" found by Johnson, and a period of 1001·21 years found by Doberck (a = 7·43"), I find the sum of the masses of the components of Castor only 0·052692 of the sun's mass, a result which would imply that the components are gaseous masses. Johnson's parallax is, however, of doubtful value. Placed at the distance indicated, the sun would be reduced to a star of 4·5 magnitude. The magnitude of Castor is about 1·55, so that it is (according to the assumed parallax) about three magnitudes, or about sixteen times brighter than the sun would be in the same position. The spectrum is of the first type, another example of the great brightness of the stars of this type. According to a well-known formula, the "relative brightness" of Castor is thirty-eight times that of the binary star, ξ Ursæ Majoris, taken as a standard. The latter star has a spectrum of the second type.

5. α Centauri.—This famous star, the nearest of all the stars to the earth, as far as is at present known, forms an object of especial interest, particularly as its spectrum is, according to Professor Pickering, of the second or solar type, although with some peculiarity. Combining Dr. Gill's parallax of 0·76" with Downing's elements of the orbit (P = 76·222 years, a = 17·33"), I find that the mass of the system is 2·04 times the mass of the sun. Placed at the distance of α Centauri, the sun would be reduced to a star of about 1·7 magnitude, or about one magnitude fainter than the star appears to us. This would indicate that α Centauri is about two and a half times brighter than the sun, and its mass (if of the same density) about four times the solar mass. As, however, there is something peculiar about the spectrum, the density and intrinsic brightness of α Centauri may be somewhat different from that of the sun.

6. 70 Ophiuchi.—This is another star which is fairly comparable with the sun, as its spectrum is of the solar type, according to Vogel. The orbit found by the present writer (P = 87·84 years, a = 4·50"), combined with Kruger's parallax of 0·162", gives for the combined mass of the components 2·777 times the mass of the sun. The star was measured 4·11 magnitude with the photometer at Harvard Observatory. Placed at the distance indicated by the parallax, the sun would be reduced to 5·0 magnitude. This would make 70 Ophiuchi about 2·27 times the brightness of the sun. According to Dembowski, there is a difference of 1·7 magnitude between the components. If we assume that each has the same density as the sun, I find that the combined mass of the two stars would be 2·825 times the solar mass, which agrees closely with the result found from the orbit. We may, therefore, conclude that Kruger's parallax for this star is not far from the truth. The diameters of the components would be about 1,188,000 miles, and 542,000 miles, and the distance between them 27·77 times the sun's distance from the earth, or somewhat less than the distance of Neptune from the sun.

7. 85 Pegasi.—For this binary pair, a somewhat doubtful parallax of 0·054" found by Brunnow, combined with Schaeberle's elements of the orbit (P = 22·3 years, a = 0·96"), gives a mass of 11·3 times the sun's mass. Placed at the distance indicated, the sun would be reduced to a star of 7·41 magnitude. 85 Pegasi was measured 5·83 magnitude with the photometer at Harvard, so that the star is 1·58 magnitude, or 4·286 times brighter than the sun would be at the same distance. If of the same density, its mass would, therefore, be 8·872 times the solar mass, a result not differing very widely from that found from the orbit. As, however, I have no information of the character of the star's spectrum, I cannot say whether or not it is comparable with the sun.

It seems to be still very doubtful whether 61 Cygni is really a binary star, but assuming a parallax of 0·45", and the star's magnitude at 5·11, as measured at Harvard, I find that the sun is about 8·39 times as bright as 61 Cygni, and its mass, therefore, considerably greater. The star has, according to Professor Pickering, a peculiar spectrum of the solar type.

Let us now consider the close binary stars recently discovered with the spectroscope, and which are known as "spectroscopic binaries." With reference to Algol, which may be considered as a binary pair, in which one of the components is a dark body, Professor Vogel finds that the combined mass of the system is about two-thirds of the sun's mass. From the dimensions he gives for the components, I find that their mean density is about one-third that of water, so that they are probably gaseous bodies. As the parallax of this star has not yet been determined, we cannot say what the sun's magnitude would be if placed at the star's distance, but as the spectrum of Algol is of the first or Sirian type, we may conclude that it is bright in proportion to its mass.

For ζ Ursæ Majoris (Mizar) Professor Pickering finds a mass equal to forty times the mass of the sun. Klinkerfues found a parallax of about 0·045" for this star. At this distance the sun would be reduced to a star of only 7·8 magnitude. The Harvard measure of ζ Ursæ is 2·38. It is therefore 5·42 magnitudes, or 147 times brighter than the sun would be at the same distance. It should therefore be, if of the same density, 1,787 times the mass of the sun. But the spectrum is of the first type, and the star is therefore not comparable with the sun in its physical constitution. We have here another example of great brightness in proportion to mass.

β Aurigæ was discovered to be a close binary with the spectroscope at Harvard Observatory, and the discovery has been fully confirmed by the observations of Professor Vogel at Potsdam. The period is about four days, and the distance between the components about sixteen millions of miles. From these data I find that the mass of the system is about five times the mass of the sun. Recent photographic measurements by Professor Pritchard at Oxford have yielded a parallax of 0·059" and 0·065" (*Observatory*, June, 1891). Taking a mean of these results, or 0·062", we have the sun reduced to 7·17 magnitude if placed at the distance of the star. β Aurigæ was measured 1·94 magnitude at Oxford and 2·07 at Harvard. We may therefore assume its magnitude at 2·00. This gives a difference of 5·17 magnitudes between the light of the sun and that of β Aurigæ. In other words, β Aurigæ is 117 times brighter than the sun would be if placed in the same position. If, therefore, of the same intrinsic brightness of surface, its diameter would be 10·8 times the diameter of the sun and its volume 1,265 times the sun's volume. We see, therefore, that—like Sirius—this star is very much brighter than the sun in proportion to its mass. As the spectrum of β Aurigæ is of the first or Sirian type, we have here another example of great brilliancy in proportion to mass, a feature which seems characteristic of all stars of the Sirian type.

Spica.—The spectroscopic observations of this bright star indicate a mass of about two and a half times the mass of the sun. The parallax has not yet been well determined (Brioschi found a negative parallax), but judging from its small proper motion, the star's distance is probably very great. As it is a standard star of first magnitude, its brightness would seem to be enormous in proportion to its mass, and here again we have a spectrum of the Sirian type.

We may therefore conclude that binary stars with spectra of the first type—and probably all stars of this type—are very bright in proportion to their mass, while those showing spectra of the second or solar type are intrinsically much less luminous and have a brightness approximately proportional to their mass.

[Many of the parallaxes made use of by Mr. Gore in these calculations are no doubt extremely doubtful. But in such an inquiry, even the roughest estimates are of value. The evidence collected tends to indicate that stars of the Sirian type are either less dense than the sun—that is, that they are in an earlier stage of condensation—or that their photospheres are more brilliant, area for area, than the solar photosphere.—*A. C. Ranyard.*]—*Knowledge.*

INFLUENZA.

THE outbreak of influenza is spreading fast, with its customary concomitant of a highly increased mortality from respiratory affections. In the metropolis, for the week ending Nov. 28, thirteen deaths were attributed primarily to influenza, the total death rate being 19·4 per 1,000, or slightly less than the preceding week. It may be noted that the death rate at Plymouth for the week ending Nov. 28 was 38·3, or precisely double what it was three weeks previously. There has also been a rise in the death rates of Newcastle-on-Tyne and Sunderland. Influenza continues to be very prevalent in Scotland; it has appeared in a severe form at Sandy, one of the isles of Orkney. In Glasgow it is said that it has never been so widespread and severe as at the present time, and almost the same is true of Edinburgh. In both places the resources of the profession have been severely taxed. Abroad the accounts are of like import. At Berlin it has been prevailing during the past month; it has been very severe at Hamburg and Dusseldorf, and is also spreading rapidly in the Silesian provinces and Schleswig-Holstein. It has appeared again in Paris, where Professor Brouardel has stated that it was responsible for 100 deaths during the past week. The Australian mails bring accounts of the deaths of several prominent Melbourne citizens from influenza, and it will be noticed that our New Zealand correspondent also speaks of its prevalence.

ISOLATION IN INFLUENZA.

By J. R. LEESON, M.D., Late Demonstrator of Anatomy at St. Thomas's Hospital.

INFLUENZA now occupies the greater part of the general practitioner's work and thought. It is, save for last year's experience, a new disease to the men of this generation; the public are bewildered, and the honest "medicine man" has to confess to his inquisitive patients that nothing hardly is known about its cause or mode of spread. The hypothetical germ has not been found; the general practitioner has neither time, nor special skill, nor apparatus to hunt and find it. The government, with that remarkable economy which seems to affect all political parties, vote no supplies, and institute no inquiries which might enlighten the mind and alleviate the sufferings of the public. We say "it is in the air," that it is due to "atmospheric influences," and the stricken country pacifies itself with such platitudes, and resigns itself to a species of fatalism and careless conduct in consequence. Sir Thomas Watson in his classical lectures, with rare and prophetic insight, concluded forty years ago that the contagion of influenza, whatever it was, was "particulate."

Viewing influenza in the light of recent researches upon acute specific fevers, there is everything to warrant us in the induction that it is a germ disease; the analogy is complete. My object in this fragmentary contribution is to draw attention to an experiment which to my mind proves that it is not "in the air," in the commonly accepted sense of the term, but passes from the sick to the healthy in much the same manner as do ordinary infectious fevers. Twickenham has been ravaged by the disease. The Metropolitan and city police orphanage here, containing nearly 300 souls, is under my medical care. When the disease appeared in our neighborhood, I was particularly desirous that the orphanage should not be attacked. My time being very fully occupied in coping with the disease among the inhabitants of the district, I was especially anxious not to have a sick orphanage under treatment at such a time; added to which, the known tendency of many of the orphans to suffer from pulmonary complaints (many of the fathers having died from phthisis) induced me to take especial care for their safety. I therefore prevailed upon the authorities to institute a most rigid system of isolation. The children were not allowed to go to church, the officers were entreated to keep within the walls and grounds of the building, all visiting was stopped both of parents and friends, and the "old boys' day" on Whit Monday (when former pupils come from all parts to visit their old home) was suspended. Now, although the disease has prevailed all round the institution, even in the head master's house, which is situated near the school, I am pleased to be able to state that no case has occurred among the inmates. I consider this a conclusive proof that the disease is not "in the air," otherwise the children must have shared the fate of the surrounding families; but that it passes from the patients to their friends and neighbors, and those who come into immediate contact with them, in the same way as do measles and scarlet fever. In previous years, when epidemics of scarlet fever and measles have prevailed in this neighborhood,

we have always endeavored to preserve the children from infection by adopting the same means as are now in force against influenza, and our success has been nearly as complete. My object in publishing this is to show that influenza can be dealt with as successfully.

Let us adopt as a working hypothesis the germ theory for this disease; let all sufferers be treated with the same precaution as if they were suffering from scarlet fever or even small-pox (the germ for which, I believe, has not yet been discovered), and I think if on the appearance of the disease rigid isolation were practiced, the epidemic might be averted, and thus many lives and much suffering spared. In places where the disease is widespread it is too late to do much in this direction, but in unaffected districts medical men and the public should be fully alive to the necessity for and wisdom of such a course. "Nothing succeeds like success," and I point to this method and experiment as showing that a colony of 300 people have been preserved from the ravages of a disease which has raged all around by adopting this simple and common sense plan of procedure.

I should like to add, in conclusion, that my partner, Dr. Bolton, has had several very clear cases which seem to place the period of incubation at about five days; he has also drawn my attention to the influenza tongue, which he says is an "anæmic tongue," *the edges being usually indented*, in addition to its dorsum carrying a thin white fur, and, as far as I know, he is the first to recognize its anæmic character. My impression is that the disease is most infectious in its early stages, and I believe a week of isolation will be sufficient for most cases. Antipyrin in twenty-grain doses every four hours has a magical effect upon the pains; the treatment for the subsequent debility during convalescence is unsatisfactory; time, rest, and nourishment are the chief factors.—*Lancet.*

PANTELLERIA, AND ITS THERMAL SPRINGS.

By G. GERVIS.

ONE hundred and forty miles to the west of Valletta is the little town of Pantelleria, built at the northern extremity of the island of the same name, which constitutes one of the 12 Sicilian volcanoes, and is likewise the largest of the numerous outlying islands belonging to Sicily.

Pantelleria, situated midway between Sicily and Tunisia, in that part of the Mediterranean known as the African Sea, is exclusively of volcanic origin. The view from the sea on entering the little port is fine and highly picturesque, the town occupying the gently rising ground behind the beach, while the cultivated land on the slope of Monte Sant' Elia is pleasantly dotted over with small houses in the midst of vegetation of a southern type. Above all, in the background and flanked by minor eminences, rises the Montagna Grande, the height of which is not so very much less than that of Vesuvius, while the entire mountain mass of the island taken together is far greater, and the general outline, to my mind, infinitely more beautiful.

Somewhat elliptical in form, Pantelleria measures 8¼ miles in length from N.W. to S. E.; its breadth in the direction of N. E. to S.W. is 4½ miles, and the area 25,423 acres. Toward the south of Pantelleria rises the Montagna Grande, 836 meters (2742 feet) above the level of the Mediterranean, separated by a narrow ravine or valley on its southern slope from the Gibel, the Arabic word for mountain, redundantly called Monte Gibele, 700 meters (2296 ft.) high. Still further south is the Cudda Attalora, 560 meters (1837 ft.), while Monte Gelkhamar, to the west of the Montagna Grande, rises to the height of 289 meters (948 ft.), and lastly Monte Sant' Elia, already alluded to, above the town of Pantelleria, about the same height as the former one. Long lines of bold precipitous cliffs, many hundreds of feet high, are prevalent on the south and east sides of the island, clearly marking the considerable wear of the coast line, while at the northern extremity the ground slopes gently toward the sea, and thus we are prepared to find that the depth of water in the lilliputian port is only about two fathoms in mid-channel, just sufficient for small coasting and fishing craft to take shelter behind the eastern point.

This remote corner of Europe is the home of 7178 persons, who are well-nigh unknown to the rest of humanity, and who know still less of the world themselves, with the rise and fall of empires, to care to rack their brains with the book learning of their fellow men, or trouble themselves with inquiring into such superfluous matters as steam machinery or electric lighting. Pantelleria town has 3,167 souls; the remaining 4,148 inhabitants are divided among five scattered groups of country cottages, rather than villages, for as "Judah and Israel dwelt safely, every man under his vine and his fig tree" in the days of King Solomon, (I Kings, chap. 25), so it literally now is with the Pantellerians under King Humbert, viz.: Khamma, 1374; Scauri, 1319; Napolicibile, 510; Margana, 596; Bugeber, 349. Administratively all belong to the commune of Pantelleria, which forms part of the province of Trapani.

The tracks used by the Pantellerians have been preserved with the most religious care in the precise condition in which they were long before the glorious days of Carthage, which rose almost in sight of the island; and in jolting along these rough stony places it needs to be lamentably devoid of all the pleasures of inspiration not to have proud visions of the good old times when Mother Earth was some 3,000 years younger than she is now, and had been drenched with the life's blood of some billions less of her sons, pitted in mortal strife against each other for no purpose but the wanton pleasure of destruction. Descending from these heights, the matter of fact geologist gets easily reconciled to the slight inconveniences of the way, finding a splendid race of large asses to ride upon, similar to those of Egypt, as he passes, hammer in hand, through vineyards and plantations of cotton, capers and other vegetation, grown on the rich decomposing volcanic soil, and freely alternating with a variety of lithological forms of eruptive rock, here scoriaceous, further on massive or cellular, in some cases rough to the touch, elsewhere so like the prosaic refuse heaps of some common black bottle works as to require close inspection in order to disillusionize him.

To the best of my knowledge no eruption of this volcano is recorded during historic times, but it is evident that the numerous prehistoric eruptions which took place in succession emanated not only from the center crater, as generally happens with Vesuvius, but likewise from numerous lateral vents, now forming the various minor eminences met with in various parts of the island. But it would not at all surprise us should an eruption of considerable local importance break out here at some later date, seeing that to a certain extent much analogy of constitution may be traced between the islands of Pantelleria, Lipari with its satellite volcano, and Ischia, in the two latter of which islands we know of more than one recorded eruption during historic times, although many authors seem to be disposed to classify them among extinct volcanoes.

In order to complete this rapid sketch of Pantelleria, off the coast of which a submarine eruption took place last October, preceded by earthquake shocks, it will be useful to say a few words about the general configuration of the bed of the African Sea in this neighborhood between the coasts of Sicily and Tunisia.

In a direct line the distance by sea from Pantelleria to the nearest point in Sicily is 53 miles; to Africa it is only 34 miles. For a distance of nine miles toward Sicily the greatest depth of water is from 130 to 240 fathoms, and in one spot it even reaches 315 fathoms. Further on toward Sicily the 100 fathom contour line, the deepest measurement found in that direction, embraces a wide area, the depth diminishing to the 50 fathom contour line as we proceed onward from 3 to 5 miles. A slight upheaval of the bed of the sea of only 40 fathoms would convert the Adventure Bank, situated at about 40 miles from Pantelleria toward Marsala, into a long island, larger even than Pantelleria itself, measuring 14 miles long from northeast to southwest by 3 miles broad, and rising but slightly under 200 feet above the sea level.

Again, 37 miles from Pantelleria to the N. E. and 25 miles from the town of Sciacca on the south coast of Sicily, is the Graham Shoal, marking the spot where the submarine eruption took place in the year 1831, resulting in the formation of Graham Island, which before Christmas day of the same year sank beneath the waves, never yet to reappear. The summit of this new volcano was seen for many years at a depth of only 10 feet below the surface of the water, but subsequently it subsided considerably, and in all probability this year it will have undergone considerable change of level, owing to the volcanic phenomena above alluded to. Several lesser submarine eminences are noticeable within the 100 fathom contour line, which is shown by English soundings made in this neighborhood to have a diameter of from 10 to 15 miles. Outside this contour line, at distances varying from 2 to 10 miles, the deepest soundings are to be met with, ranging from 130 to 169 fathoms—these latter depths being *nearest the shoal.*

Proceeding in the opposite direction, the 100 fathom contour line is never more than 12 miles distant from the Tunisian coast, and the greatest depths outside this line toward Pantelleria are from 172 fathoms to 250 fathoms.

In a word, generalizing, the greatest depth of the sea appears to be within the distance of only a few miles from Pantelleria, and from the Adventure Bank and Graham Shoal, which are submarine volcanoes; further off, the depth regularly diminishes in approaching land constituted of sedimentary strata. East of Pantelleria, in the direction of Malta, we find the two little volcanic islands of Linosa and Lampedusa, so that this is exclusively a volcanic region, characterized, moreover, by habitual lethargy than activity, a word scarcely applicable to any of the island volcanoes around Sicily, though *none of them are by any means extinct.*

Like Ischia, Pantelleria boasts of thermo-mineral springs, highly mineralized, which might assume much therapeutic and economic importance, yet in modern times they have never attracted attention, such as the Romans and Arabs at least gave them, if not former people, in centuries long ago passed into oblivion, for the Mussulmans were expelled from this island in the year 1147. They could not now be less known in Italy and elswhere, even to scientific men, than if they had risen on the shores of the Victoria Nyanza.

I will not here repeat all I have elsewhere written on the subject of Pantelleria, or indeed of the mineral wealth and the mineral springs of Sicily in general, but refer the reader to the volumes already published.* We will now give a rapid glance at them.

To the east of the island, round the lake, are the thermo-mineral waters known to the inhabitants under the name of *Le Candareddi de lu Bagnu.*

The *Bagnu*, improperly so called, is simply an ancient volcanic crater, formed of vitreous rocks about a mile in circumference; it is not far from the Bagno Secco. Owing doubtless to the admixture of rain water, the temperature is lower than that of the Candareddu de lu Bagnu.

Northward of this is the *Acqua della Grotta di Gadir*, consisting of several springs close to the sea shore, and owing their thermality and mineralization simply to the chemical decomposition of liparite and cossyrite in the presence of atmospheric influences.

About 12 miles from the town of Pantelleria, and at the southwest end of the island, is the *Acqua della Cala Nita*, the most highly thermalized of any, a fact which is due to the decomposition of the white liparite; it is therefore easy to account for the thermality of the sea itself in this precise locality.

The *Acqua del Porto di Saura Basso*, on the same side of the island, some 5 miles nearer the town, is also very hot.

Proceeding northward along the west coast, some 5 miles from the town, is the hot spring known as the *Acqua salina di Sataria*, supposed to have been used for baths by the Romans or Arabs. This spot is rather difficult of access by sea or land, being situated in a grotto. The water comes out of pumice stone underlying liparite, but it doubtless derives its high temperature and mineral constituents from this latter rock.

Next comes the *fumaiolo*, or emanations of aqueous vapor, simply indicating the subterranean seat of strong chemical decomposition in the volcanic rocks, and termed the *Bagno secco.* This is situated in a little grotto in the midst of the rock, and forms *Stufa* or *Sudatorium.* The *di Khasan* was formerly employed by the Arabs *Stufa* as a *Sudatorium.* Another *fumaiolo*, called the *Favara Grande*, is met with on the northeast slope of Monte Russo.

As to the minerals met with in the island of Pantelleria, mention may be made of sulphur, formed in the ancient *fumaioli*, but in quantities too insignificant to be of any economic importance. Such is the quantity of alkaline bicarbonates in the waters of the Candareddu de lu Bagnu, and the Cala Nita, as to react powerfully upon the silica of the rock in contact with them. It is first transformed into soluble gelatinous silica, and then deposited in the form of dirty white or gray opal. Obsidian is common among the volcanic products, and is due, as it is well known, to the rapid cooling of the rock, such as takes place in submarine eruptions, similar to the one which manifested itself last autumn. Pozzolana and pumice stone are also common, besides minerals of purely scientific interest. But here I will stop for the present, hoping to persuade Prof. Cooke to devote some time to a visit to Pantelleria in order to enlarge our acquaintance with the geology of this interesting island. G. JERVIS.

—*Mediterranean Naturalist.*

* Jervis, G.—"I Tesori sotterranei dell' Italia," vol. III.—Le Isole, illustrated.
Jervis, G.—"Guida alle Acque Minerali dell' Italia a Meridionale," illustrated.

THE TREATMENT OF PHYLLOXERA WITH CARBON BISULPHIDE AND VASELINE.

THE reinvigoration of the French vineyards by grafted American plants has not put an end to the efforts directed toward the preservation of plants attacked by phylloxera, by means of insecticides.

Bisulphide of carbon, pure or dissolved in water, sulpho-carbonate and submersion still continue to be employed with varying success, the nature of the soil, specific strength of the various plants, etc., having much influence on the result.

These different remedies are not all capable of general application; submersion is necessarily limited to certain districts; sulpho-carbonates also require water and costly management, which cannot be afforded by all vine growers; and bisulphide of carbon dissolved in water requires a set of apparatus which is too costly for any but large growers.

This last named substance has, however, proved, during recent years, to be the most certain insecticide, and its use has led to the preservation of a great part of the French vineyards.

Practice has made it apparent that bisulphide of carbon does not give quite such satisfactory results in very siliceous earth. Not easy to diffuse in some soils, and evaporating too rapidly in others, the sulphide does not so certainly produce its effect. Hence has arisen the current opinion that bisulphide of carbon suits certain soils and not others.

Since 1887, Dr. Albin Meunier has been endeavoring to render this action uniform, by assisting the diffusion of the carbon bisulphide in heavy soils, and preventing its evaporation in such as are too light, and, finally, by avoiding the injurious effect on the vine produced by a considerable amount of evaporation in soil heated by the summer sun.

The experiment was made of mixing bisulphide of carbon with petroleum oils, boiling at 300 deg. to 350 deg. (vaseline), and of density 0·850 to 0·910, which are quite without injurious effect on the plants, even when present in large quantity. Numerous direct experiments have been made with these hydrocarbons on vines.

These high-boiling substances have the property of diminishing the evaporation of the bisulphide of carbon, no doubt by entering into molecular combinations with it, such as are assumed in many mixtures of organic liquids. Bisulphide of carbon, for example, can only be separated from ordinary alcohol by fractional distillation with great difficulty (Berthelot). Methyl alcohol and acetene, benzene and toluene are further examples which may be selected from many others.

Although carbon bisulphide can be separated from vaseline by fractional distillation, on account of the great difference in boiling point, yet the evaporation of the former, at all events at the ordinary temperature, is considerably diminished by the addition of vaseline, which retains considerable quantities for days, in spite of a considerable surface of evaporation.

In very light sandy soils the use of vaseline should, *a priori*, be favorable. On the other hand, vaseline, which physically resembles the fats, readily penetrates into clay, and its use should, therefore, be also found advantageous in heavy land (clay and clayey sand).

Experience alone could decide whether these conclusions are just.

In 1887 I started on a number of experiments in this direction.

Five thousand seven hundred kilos of carbon bisulphide mixed with an equal weight or half its weight of vaseline were employed in the department of the Rhone at various places, Vangueray, Saint-Etienne-la-Varenne, Villié-Naorgon, etc.

In 1888 2,500 kilos were supplied to various proprietors in the Rhone district, who obtained such results that in 1889, 89,585 kilos, and in 1890, 242,392 kilos were employed by a large number of vine growers in the following departments: Rhone, Isere, Ain, Saone et Loire, Cote-d'Or, Loire, Ardiche, and Drome.

From the indications given in the spring of last year, the total amount of the mixture employed during 1891 was estimated at 500,000 kilos.

The vaseline mixture is applied in the same manner as the pure sulphide. In practice it is found that the efficacy of the remedy is increased by inserting one portion at a distance of 10 or 12 cm. from the foot of the vine stock and spreading the rest over the area of a hectare. Actually about 2,000 to 2,500 hectares of vineyard are under treatment in this way.

The increasing use of this remedy is obviously caused by its success in restoring diseased vines, and by the impression thus made upon the minds of the owners.

For four years I have employed this mixture on my own property, of 15 to 20 hectares, situated at Saint-Etienne-la-Varenne (Rhone). This property was kept at the average rate of production by pure bisulphide, but its production has been increased threefold by the new treatment. Phylloxera is no longer found on the

roots, the vegetation is luxurious, and numerous rootlets, a sure sign of increased vitality, have appeared.

The manure has not been altered for ten years, so that the marked improvement can only be ascribed to the use of a more rational insecticide.

These results lead us to quote the opinion of M. Balliani, stated in his memoirs on phylloxera (1876):

"The germ or embryo is much less certainly attacked by large doses of a poisonous vapor acting for a short space of time than by even very small quantities, the action of which is slow but continuous."

Bisulphide of carbon mixed with vaseline theoretically fulfills this requirement. The observed facts, of which we have given a general sketch, remove all doubt as to the efficacy of this mixture as a means of removing the evil results produced by phylloxera.—*L'Engrais, in Chem. Trade Journal.*

IRRIGATION IN ARIZONA.

By HERBERT H. LOGAN.

THOSE of you who have never seen the desert and arid lands of our Western country should imagine something a thousand times more desolate and worthless to all appearance than the sand foot hills of your Long Island coast; still, unlike these coast sand hills, enormously rich in all the elements that go to make a soil productive, but deficient in moisture to produce vegetation of any character—lands which it has often been said will support nothing but the jack rabbit—covered here and there by cacti, sage and grease brush, with occasionally a stunted growth of mesquite. It is to the arid lands of Arizona that I wish to especially call your attention.

Irrigation transforms, makes over and creates out of this desolate waste a country more beautiful, more grand and more productive than any other part of God's earth. It makes possible the creation of ideal homes. Imagine for a moment land, twenty acres of which will, in a few years, make the farmer independent; that will, after three to five years' cultivation, bring him an income of three, four, and often five thousand dollars per year; a land that produces every fruit grown outside of the tropics to perfection, where the farmer can pick from his garden the peach from the 20th of May to the first of January, and where all other fruits develop and reach a perfection only known to a southern or semi-tropical climate. What is true of the peach is true of the pear, the apricot, the prune, the fig, the nectarine, the pomegranate, the grape, the walnut, the almond, the orange, lemon and lime. A land where the orange can be had fresh from the tree every morning in the year, where the strawberry can be grown and will produce out of doors twelve months in succession; with a climate reaching almost perfection; where there are eight months as perfect as the most beautiful part of your May and October; a country of almost perpetual sunshine; where the Signal Service for a period of ten years gives an average of 340 days without a cloud in sight; where there are four of the summer months with a heat so dry that it is not oppressive, but giving that perfect development to its products which is really the wealth of the country; where barley produces sixty bushels to the acre, wheat forty bushels, and alfalfa eight tons to the acre annually, and is pastured from November until March; where there are horses and cattle that reach an early development unknown to any but the southern climates, where they are sleek and fat and live upon the green feed twelve months in succession; where there are colts at four months old that often weigh nine hundred pounds; where two years gives as perfect a development as three in the more northern sections; where frequently land under cultivation for three years, costing originally less than $100 per acre, will produce for all time a net income of $200 an acre and upward; where the profit from the orange and the lemon, the peach, apricot, pear, grape and fig is sufficient upon ten acres to support in affluence a family of five persons; where these fruits are produced from four to six weeks earlier than in any other point in the United States; a country where, had our Pilgrim Fathers found their Plymouth Rock there, this Atlantic coast would be to-day a wilderness, and roaming over it would be the native red man.

The early canals that commenced the development of these valleys were farmers' canals, built on a co-operative plan, not for profit, but by the users of the water. These canals were built along the lower or river bottom lands and covered usually a few hundred, or at most a few thousand, acres. The water system of to-day means the building of great canals that take the water from the mountains and cover the more valuable foot hill and upper mesa lands; this is the work of capital. This is being done, and with great profit. The great Arizona canal, begun in the early eighties, forty-two miles in length, thirty-six feet wide on the bottom, fifty-eight feet wide on top, carrying seven and a half feet of water, or forty-six thousand miner's inches, and irrigating about one hundred thousand acres of land, completed in January, 1887, costing a little less than $600,000, has created a value of forty dollars per acre, or over $4,000,000. Of the older canals, when I first visited this country in 1883, the stock was selling at two and three hundred dollars per share; I have since seen paid two and three thousand dollars for the same stock. In the Great Salt River valley there are now, covered by the water system, about three hundred thousand acres of land and some thirteen main canals, aggregating about three hundred miles in length, and some six thousand miles of lateral ditches, which have cost about two million dollars, and have created a value of upward of nine millions. In the Great Salt and Gila River valleys and their tributaries about 250 miles in length, and with an average width of about twelve miles, there are about 2,000,000 acres of land susceptible of irrigation. To develop the necessary water system and prepare it for settlement requires the expenditure of probably upward of twenty millions of dollars—which will create a value of over $200,000,000—and Arizona and her people are going into the markets of the world to raise that money, develop these lands and furnish homes for a million people.

I would not for one moment lead you to suppose that this is the only irrigated country of value, but I do make the statement boldly, and without fear of contradiction, that it is the richest and most productive of all the arid regions, and Arizona and her citizens extend to the rustling, bustling, energetic people of the Atlantic coast a cordial invitation to investigate her resources, and, to such as would better their condition, an invitation to abide with us and help us develop that great and magnificent territory into one of the richest States in the Union. And in behalf of our people I assure you that, should you visit this, the promised land, the garden of the world, the home of sunshine and silver, you will receive a hearty welcome.

CHRONIC BRONCHITIS.

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